MODEL STUDIES OF TIMBER SHELL ROOFS

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ABSTRACT

The effects of four types of fastening and of scaling on the properties of a timber shell membrane were studied. The membrane was a three layer type made of ex 4 X 1 in. T & G radiata pine boards, the centre layer running at right angles to the outer layers. The fastenings were three densities of nailing and one of nail-gluing. Timber properties were characterised by grading modulus (g.m.) which was the stiffness of prototype boards on the flat under centre point loading over a 3 ft span while the fastenings were characterised by the load-slip behaviour of representative joints. The joint behaviour showed little correlation with g.m.

Prototype and 1/5 scale model elements were tested in compression, shear, bending and torsion and elastic constants were computed. The various constants were affected to different degrees by the four types of fastening according to the level of stress carried by the fastening under the various element loadings. The model similitude obtained in the elements was good when this was based on g.m., the load-slip behaviour of representative joints and the weight of glue spread per unit area of glueline.

Two 1/5 scale model cylindrical timber shells were built and tested, one nailed and the other nail-glued. Their deflections were about twice those calculated by a simplified analysis for orthotropic shells. Their relative behaviour was similar to the relative behaviour of the model elements in shear which suggests that the discrepancy between calculated and observed deflections arose from shear deformations which the analysis ignored.

ACKNOWLEDGEMENTS

(Proverbs 16:3)

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CHAPTER ONE

INTRODUCTION

1.1 GENERAL

Attractive and comparatively cheap shell structures can be built from layers of boards connected either by mechanical fasteners or by an adhesive.

Particularly in Britain since the mid-1950s a number of industrial and educational buildings have been roofed with timber shells. These roofs have performed well in service. The hyperbolic paraboloid (h.p.) has been the predominant shape among these with other shapes such as the conoid, the elliptic paraboloid, the sphere and the cylindrical shell being used only occasionally.

The earliest use of timber for shell roofs was in the 1920s in Russia with the construction of a number of cylindrical shells of large span and, by present standards, of heavy construction. The largest of these was 95 ft wide with a span of 320 ft although it has been reported(1) * "to have suffered considerably from large deflections."

This problem of deflection is usually the governing design criterion rather than strength. It is common to most timber structures and arises from a low modulus of elasticity often accompanied by flexible jointing systems and is also affected by fluctuating moisture content. Estimation of the deflections of timber shells is often rendered difficult by the complex properties of the boarded membranes, and for shells with mechanical fastenings, of very doubtful precision since mechanical fastenings do not exhibit elastic properties.

Consequently, current trends are towards modest spans of about 60 ft, for which satisfactory designs can be produced from approximate analysis

*superscript numbers in parentheses refer to referenced literature combined with engineering judgment. For larger structures, particularly those with mechanical fastenings, the dangers of excessive deflections and buckling are considerable and approximate analysis is no longer satisfactory. In such cases recourse is usually made to experimental study.

In experimental studies it is desirable to work on small scale models for economy, ease of testing and control of ambient conditions. However, small scale models (say less than 1/10 scale) are possible only with a glued construction because of the physical difficulty of driving fasteners shorter than about $\frac{3}{8}$ in. Nevertheless the shell with mechanical fasteners is less costly than a glued one to build and so is the shell which a designer will prefer.

It follows then that if the relative behaviour of mechanically fastened timber shells and glued shells were known, or could be easily determined, then the performance of prototype mechanically fastened shells could be predicted from the performance of cheap, small scale model glued timber shells.

1.2 LITERATURE SURVEY

The papers by Lee(2), Pestman(3), Booth(4), and Tottenham(5) and the discussion on shells at the First International Timber Engineering Conference in 1961, probably comprise the most concise statement of the work on timber shells to that date.

Lee describes his study of the relative effects of plain wire nails, grooved shank nails and nail-gluing on the behaviour of shell elements under shear, bending and torsion. The stiffness of the glued elements were found to be 4.6, 2.8 and 1.3 times respectively that of the nailed elements under the three types of stress mentioned. He also describes the construction of a nail-glued conoid shell roof with three layers of $\frac{3}{4}$ X $5\frac{1}{2}$ in.

tongue-and grooved (T & G) boards laid along the straight generators and at $\pm 60^{\circ}$ to this direction.

Pestman briefly describes shear tests on an element representative of the membrane of a nail-glued h.p. shell of three layers laid in the directions of two adjacent sides and the tension diagonal. An ultimate stress of 1140 psi was observed which provided data for the design and testing of a single half-scale h.p., 13 ft square as well as an assemblage of four of these shells. This work led to the construction of several h.p. roofs in Holland, all with nail-glued membranes.

Booth describes the testing of a 29 ft span by 12 ft wide half-scale nailed conoid shell of three layers of $\frac{3}{8}$ X $2\frac{1}{2}$ in. T & G Redwood boards laid along the generators and at $\pm 30^{\circ}$ to this. The shell was considered to be too flexible even when the front and rear tied arches were triangulated to form bowstring trusses. Hence the prototype conoids resulting from this work were nail-glued. Booth evidently experienced difficulties in testing as he remarks: "to get the maximum information from a test on a timber shell roof the test should be undertaken in a laboratory equipped with temperature and humidity control. The loading of the model should also be carefully controlled".

Barron[(6)] followed up the above-mentioned work by testing a model conoid constructed to 1/30 full size in balsa and glued instead of nailed. He found agreement within 10% at $13\frac{1}{4}$ lb/sq ft uniformly distributed load (u.d.l.) between his and Booth's conoid if deflections due to edge member deformation and that due to membrane deformation were multiplied by different scale factors. These factors were determined by testing in flexure elements representative of the edge members and of the membrane respectively. However at $27\frac{1}{2}$ lb/sq ft and with the front and rear tied arches triangulated to form bowstring trusses, Barron's model predicted deflections of about twice those observed on Booth's model. Reasons for this lack of agreement were (a), the non linear load deformation behaviour of the small model and (b), lack of model similitude in the mechanical fastenings of the bowstring trusses. Examination of the respective deflection patterns for these models suggests a third reason: that they developed different but stable buckles in the membrane.

Tottenham discusses methods of analysing the various shell shapes and states that: "the two basic problems in analysis of timber shells are (a) those relating to timber, and (b) those relating to elastic shells". While the second set of problems has received much attention particularly with the advances in computer technology, the first has not. In my opinion it is possible that analytical techniques could develop to the degree that the anisotropic, inelastic properties of nailed timber shells could be handled. Tottenham concludes: "(a) Although a variety of forms of shell roofs can be designed in timber there is a dearth of experimental evidence to check the design methods. Site investigations tend to have even less validity with timber shells than they do for reinforced concrete shells owing to the variability of the properties of timber and the rapid changes of strain that can accompany changes of humidity of the surrounding atmosphere. (b) The forms of roof for which the design methods may be considered satisfactory are the cylindrical shell, the spherical shell, and the elliptical paraboloid shell, these then are the most suitable for immediate laboratory investigation. (c) The great popularity of h.p. and allied shapes among architects raise more serious problems. Considerable research is required both in the theoretical and experimental fields in order that more adequate design techniques may be evolved. (d) Basic data on the elastic properties of boarded assemblies is also required for incorporation into design formulae. (e) Finally the low value of Young's modulus for timber, together with the low 'effective' stiffness of a timber shell means that elastic instability or buckling is a serious problem".

Point (c) above has since been investigated by Keresztesy[7] who tested 55 inch square 1/12 scale h.p. shells constructed of four layers of 1/16 X $\frac{3}{4}$ in. wood strips laid in the direction of the compression diagonal, the two sets of straight generators, and the tension diagonal respectively, fastened together with a casein glue. Two types of support conditions, namely: built-in at the two low support corners, and pivoted at the support corners with two edge beams adjacent to one high corner supported by columns, and three sizes of edge beam were investigated to produce design nomographs for prototype shells up to 100 ft side length on the criterion of maximum allowable deflection under uniform vertical loading. Further work on a quarter-scale diamond shaped h.p. was conducted by Keresztesy[8] and compared with mathematical analyses from which he concludes that "the stress distribution over a substantial part of the shell can be determined by the membrane theory and that bending moments occur only in a certain zone along the edges. The largest bending stresses are usually about 10 to 20 per cent of the permissable stresses under normal loading conditions, and the simultaneous membrane stresses are also very low. Due to the fact that timber resists tension and compression equally, the bending stresses should never affect the safety of the structure, and, as far as stress analysis is concerned, the membrane theory can be regarded as a satisfactory approximation". It appears then that Keresztesy has produced ample information for the confident design of glued timber h.p. shells.

A further reported work on a model shell is that of Egner et al.[9] on a nailed, 1/7 scale, h.p. shell, 10.9 ft square in plan with the two high corners at 3.6 ft and 6.4 ft above the low corners. The membranes contained three layers of 3 X 26 mm strips laid with the outer layers parallel to the compression diagonal and the middle layer parallel to the tension diagonal. Although it would be interesting to compare this work with Keresztesy's, because all the edge beams were supported on columns at their quarter points such a comparison would be of doubtful validity. The membrane of this nailed shell appeared to be very flexible with greater deflections occurring in the membrane than at the two free high corners.

Numerous reports of prototype structures have appeared in various journals which give some details of their construction and usually no indication of the method of design.

1.3 SCOPE OF THIS STUDY

Consideration of the works described above led to a number of conclusions:

(a) Testing shell elements is a simple method of determining the basic properties of boarded assemblies and the effect on these of such variables as the arrangement of boards and the type of fastening.

(b) There is much uncertainty as to the increase in stiffness to be gained by including glue in the membrane of a shell. Lee's work indicates that the stiffness of a glued element is not likely to be a constant factor times the stiffness of a similar nailed element but that the factor will depend on the type of stress acting on the element.

(c) The validity of a given nailed shell design could be determined by testing a very small scale, say 1/24th, glued shell if the relative deflection of nailed and nail-glued shells of that design were known.

(d) Since these shells exhibit low stresses in the membrane and for modest spans adequate stiffness is gained by nail-gluing, they seem a useful means of using large quantities of low grade timber of which New Zealand has an abundance.

Arising from these conclusions, it was decided to investigate the effects of the type of fastening and of scaling on the properties of the membrane of a shell by means of tests on shell elements according to the following programme:

1. Determine properties typifying the components of a shell membrane, namely the boards and their fastenings.

2. Relate these properties to a suitable property of the timber that can be used as an index parameter.

3. Determine the elastic properties of shell elements for different types of fastening.

4. Repeat step 3, working in as small a scale as possible and determine the model-prototype relationships for the various properties.

5. Compare model shells with different types of fastenings.

The timber used throughout this study was *Pinus radiata* D.Don since this is the most economically and structurally important timber in New Zealand.

The type of prototype membrane studied was constructed of three layers of 3/16 X $3\frac{1}{2}$ in. T & G boards arranged with the middle layer at right angles to the outer two. This type was chosen because:

(a) it was simple to construct and analyse,

(b) both of the locally-built shell roofs used this arrangement,

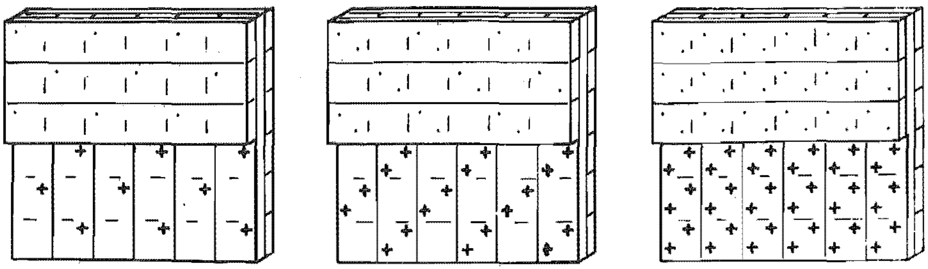
(c) it was similar to plywood and possibly plywood theory would therefore be relevant.

The fastening methods chosen for the prototype elements were nailing in the three patterns in figure 1.1 and nail-gluing using an urea-formaldehyde resin with gap-filling hardener at a rate of 0.1 lb/sq ft/glueline with the second nailing pattern. Ignoring the nails between the 2nd and 1st layers, the nailing patterns 1, 2 and 3 gave 5.8, 11.6 and 23.2 nails/sq ft respectively. According to Lee, 10 to 12 nails/sq ft is a common nailing density.

The circular cylindrical shell was chosen for the model study because:

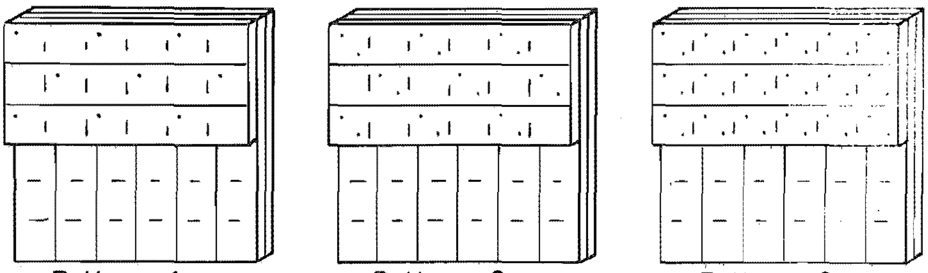
(a) it was found from the elements tested that the type of fastening had a marked effect on their behaviour in shear and in flexure but not in compression parallel to a layer of boards. A cylindrical shell should illustrate this effect more than a typical hyperbolic paraboloid constructed with the boards laid parallel to the diagonals since, to a first approximation, under u.d.l. the h.p. produces only stress parallel to the directions of the boards while shear is also produced in the cylindrical shell;

(b) it was simple to construct and suitable formwork was already available.



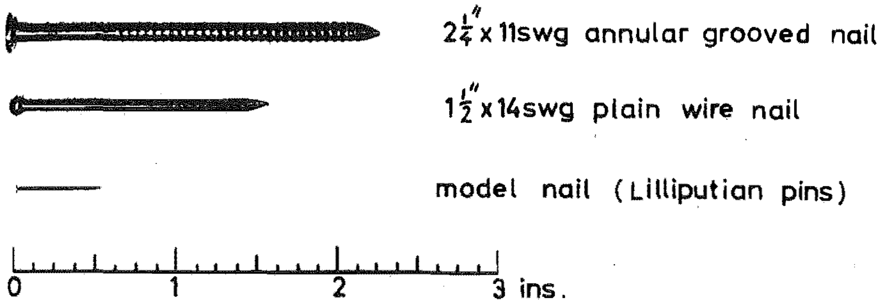
+ $1\frac{1}{2}''$ x 14swg plain wire nails through 2^{nd} and 1^{st} layers
· $2\frac{1}{4}''$ x 11swg annular grooved nails through all 3 layers

(a) Nailing patterns in prototype elements



· model nails through all 3 layers

(b) Nailing patterns in model elements.



(c) Prototype and model nails

FIG.1.1 Nailing patterns and nails used in this study.

The property used as an index parameter was the stiffness of the prototype boards as determined by the type of mechanical stress grading machine used in New Zealand. This property was called the "grading modulus" and from an engineering point of view is a much more significant and readily measured property than is the commonly used property of density which is undoubtedly a useful reference for laboratory work.

The scale for the model work was 1/5. This gave a model board width of 0.7 in. which was easily obtained from the prototype boards of 0.85 in. thickness. The model element thickness was thus $\frac{1}{2}$ in., the length of the shortest available nails.

The types of nail used were $1\frac{1}{2}$ in. by 14 s.w.g. plain wire nails through the middle and bottom layers and $2\frac{1}{4}$ in. by 11 s.w.g. annularly grooved shank nails through all three layers. This represents typical timber shell construction. Grooved shank nails are used in preference to plain wire nails to avoid the danger of the nails "working out" and puncturing the weatherproof covering. Also, they probably provide a greater pressure between the layers for gluing although this is not known for certain.

CHAPTER TWO

GRADING MODULUS CONCEPT

2.1 DEFINITION

If a board is simply supported "on the flat" over a 36 in. span and is centrally loaded by a point load, then the modulus of elasticity calculated by simple beam theory is called the "grading modulus" at that midspan point.

$$\text{i.e.} \quad E = \frac{P\,L^3}{48\,I\,\Delta}$$

where E = grading modulus (psi)

P = central point load (lb)

L = span (36 in.)

Δ = midspan deflection (in.)

This definition arises from the common use in New Zealand of the Australian-developed "Microstress" stress grading machine which applies a predetermined load in the above-described manner to a board and marks it according to the observed central deflection.

2.2 PROTOTYPE BOARDS

For this study approximately 20,000 linear feet of ex 4 X 1 in. T & G kiln dried radiata timber was obtained from a local merchant. This timber was all that could be converted in this size from logs from dominant and co-dominant crown class* trees. Since no visual selection was applied to

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* Two further crown classes are sub-dominant and suppressed. These classifications refer to the height of a particular tree relevant to the average heights of surrounding trees.

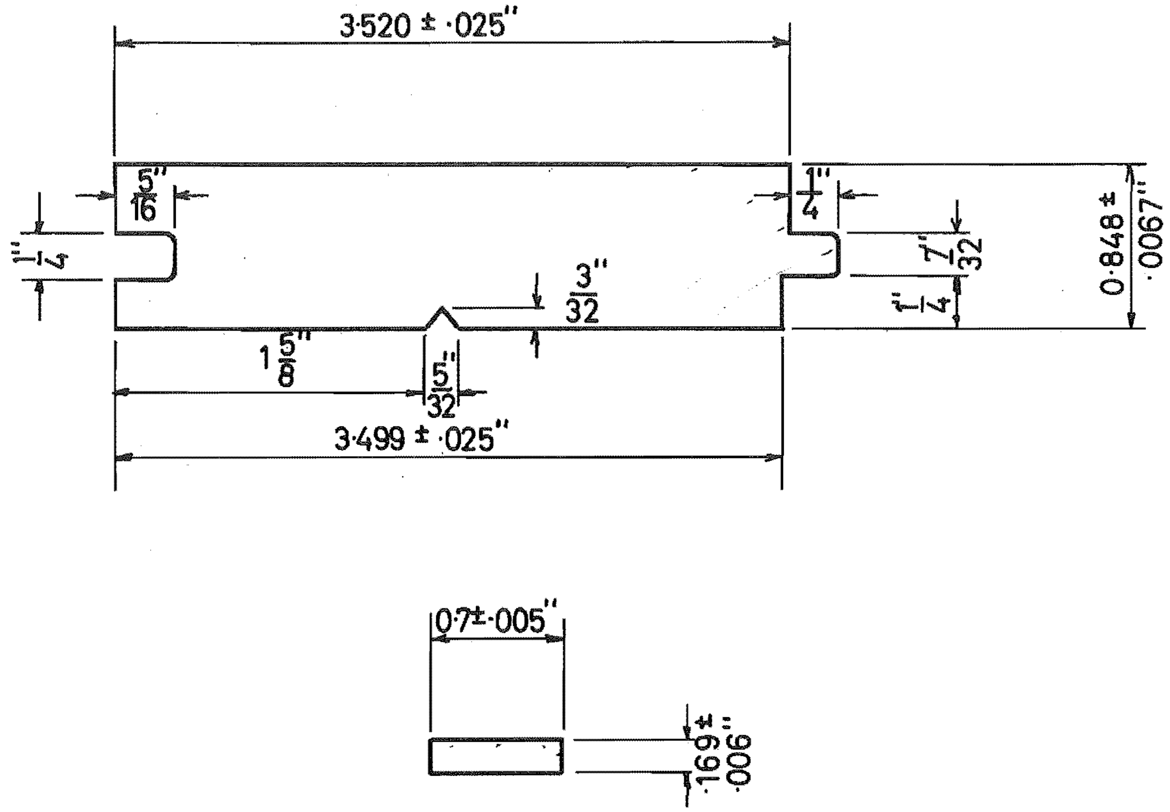
this timber about 25% of it would normally be classified as Box grade. The fillet-stacked timber was allowed to reach equilibrium moisture content (e.m.c.) for laboratory conditions. This e.m.c. ranged from 9-12% in individual samples with a mean of 10.7%. As testing for grading modulus proceeded the timber was block stacked, i.e. without fillets, thus preventing further change in moisture content except for the outermost boards which continued to be affected by fluctuations in laboratory conditions. The average cross-sectional dimensions are shown in figure 2.1.

The grading modulus was measured at 36 in. intervals using the apparatus shown in figure 2.2. The deflection at midspan caused by a 20 lb weight was measured with a dial gauge graduated to .001 in. but whose reading was estimated to .0001 in. A preload of 10 lb on the 5 lb hanger was usually necessary to ensure a firm bearing on both roller supports. The grading modulus was calculated with a slide rule and recorded at the point of measurement on the board.

The deflection caused by a 20 lb weight was measured since a "Micro-stress" grading machine would be adjusted to apply this load to timber of these dimensions. The type of visible defects which occurred in the 1 ft length about the midspan point was also recorded.

The frequency distributions of grading modulus measurements for the total quantity of prototype boards and for those points free of visible defects are given in figure 2.4.

In case an adjustment of grading modulus was later necessary due to changing moisture content, 21 boards, 37 in. long, covering most of the range of grading modulus were selected and subjected to various humidity levels, resulting in changes in dimensions and modulus. The dimensions



Note; standard deviations shown with thickness and width dimensions.

FIG.2.1 Dimensions of prototype and model boards.

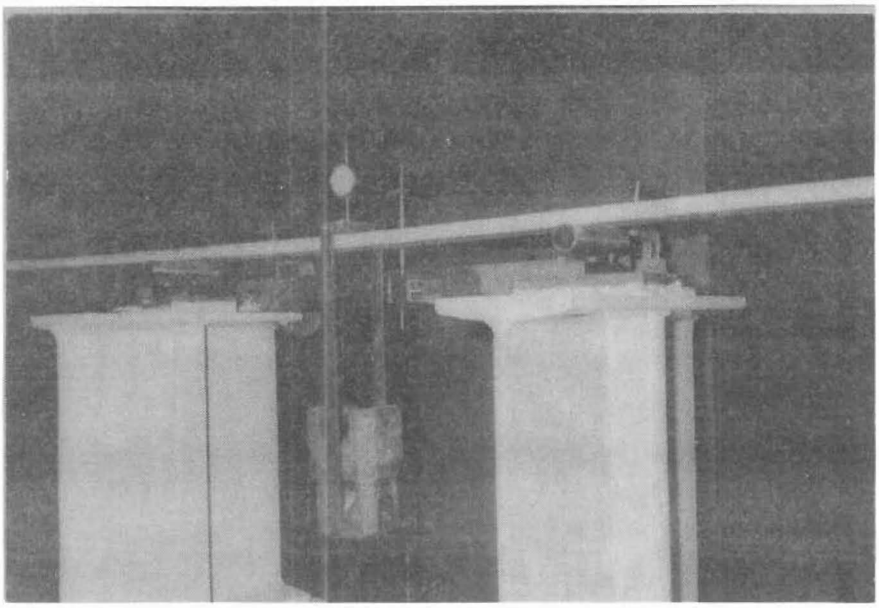


FIG. 2.2. Apparatus for measurement of grading modulus of prototype boards.

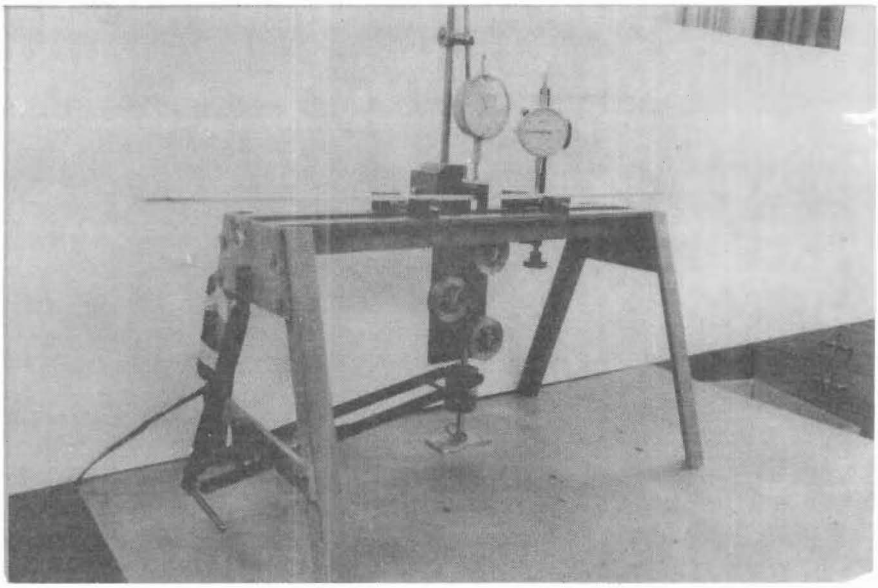


FIG. 2.3 Apparatus for measurement of grading modulus of model boards.

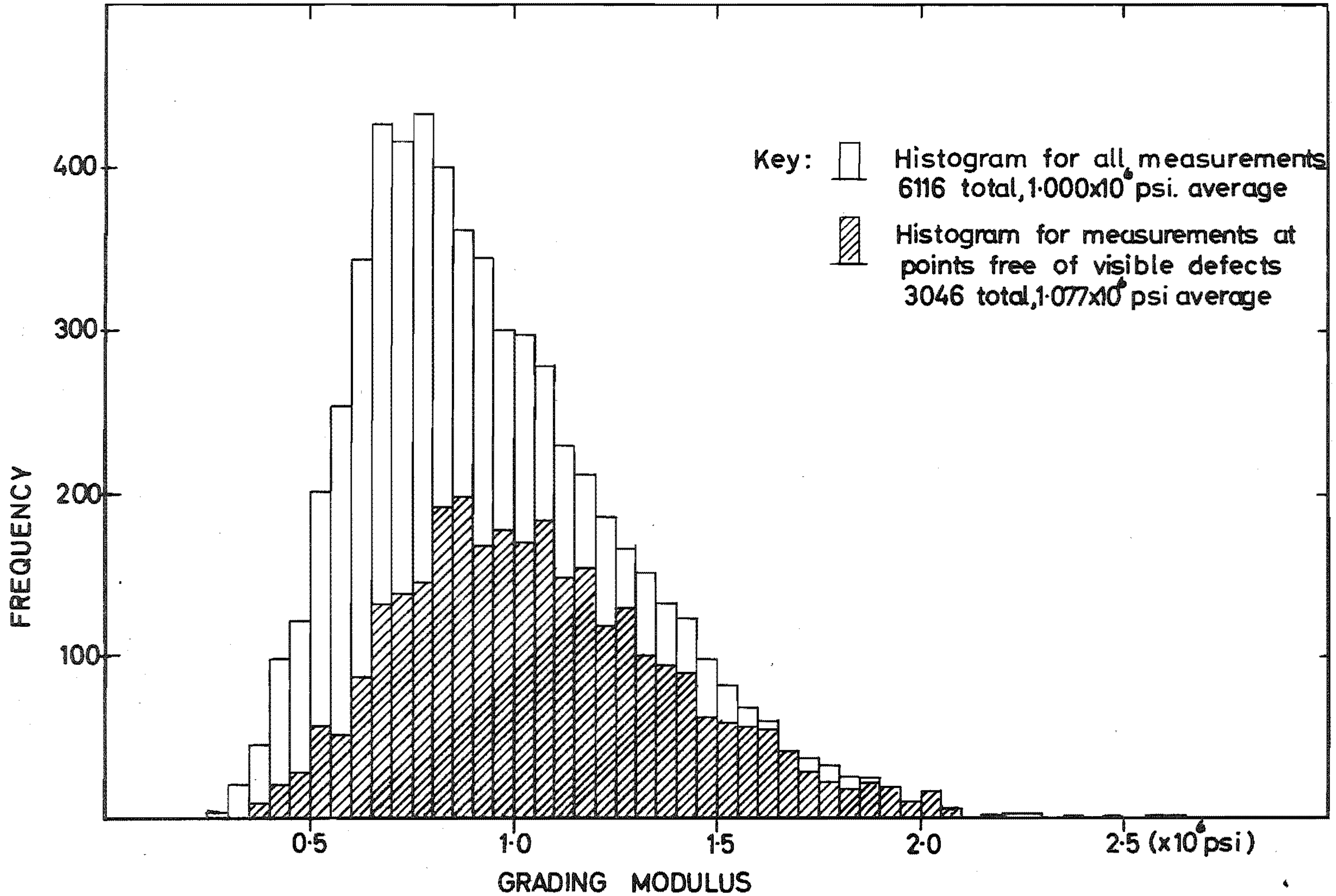


FIG. 2.4 Frequency distribution of grading modulus measurements on prototype boards

and modulus of each board were measured, the boards weighed and then open stacked in a cabinet whose humidity could be controlled. These were tested at weekly intervals covering a range of moisture content from 7-25%, working from minimum to maximum to minimum to allow for the hysteresis effect usually noted. Following this the boards were soaked for one week, measured, tested for modulus, oven dried and reweighed. The observed effect on grading modulus is shown in figure 2.5. From the fitted regression equation it is seen that a 1% moisture content change causes a 1.8% change in grading modulus.

2.3 MODEL BOARDS

Strict modelling of the prototype boards to 1/5 scale was not obtained in that the tongue and groove could not be reproduced. Instead, model boards of rectangular cross section were cut from the prototype boards. The dimensions desired were 0.7 in. by 0.17 in. which were 1/5 of the 3.5 in. and 0.85 in. average dimensions shown in figure 2.1.

A sufficient quantity of prototype boards were reduced in thickness to 0.7 $\pm$ 0.005 in. by means of a thicknesser, the wood being removed from the grooved face. Next the boards were passed over a buzzer to remove the tongue and produce a square, straight edge. The model boards were then ripped from these using a circular saw bench with a planer blade set 0.17 in. from the fence. Rubber tyred rollers were set up to guide the timber firmly against the fence and the actual thickness obtained was 0.1689 $\pm$ 0.0058 in.

To determine the grading modulus of the model boards the apparatus shown in figure 2.3 was designed to reproduce the function of the prototype apparatus to 1/5 linear scale. It consisted of a frame with two $\frac{1}{2}$ in.

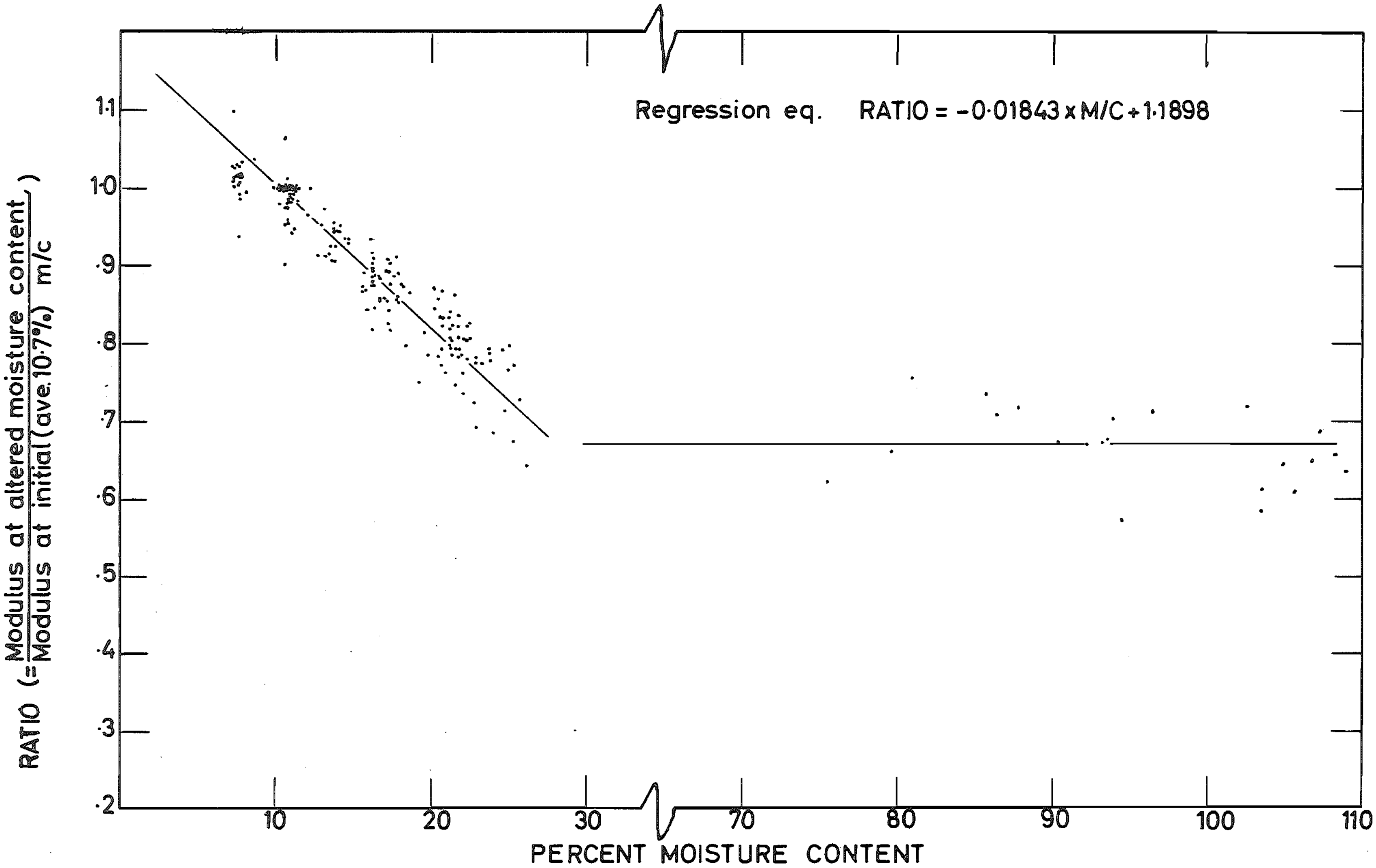


FIG. 2.5 Change of grading modulus with moisture content for prototype boards

diameter rollers at 7.2 in. centres with a hanger at midspan guided vertically by three ball bearing wheels.

A weight of 0.8 lb could be placed on the hanger or held clear by a lever and clip arrangement. A dial gauge graduated to 0.001 in. recorded the vertical movement of the hanger while a second dial gauge above the right hand roller measured the thickness of the model board. It was necessary to use the actual rather than the mean value of thickness since the coefficient of variation of 3.5% in the thickness would produce an apparent 10.5% c. of v. in the grading modulus. A vibrator attached to one leg of the apparatus was effective in overcoming friction to give repeatable results. The modulus was measured and recorded at 4 in. intervals, being calculated from the observed deflection over the 7.2 in. span caused by the 0.8 lb weight.

The frequency distribution of the modulus values of the model boards and of the prototype boards from which they were cut are shown in figure 2.6. A more symmetrical distribution was obtained than that for the prototype boards in figure 2.4. The presence of defects in the prototype boards would appear to account for this because it is seen in figure 2.4 that boards without visible defects give a more symmetrical distribution than does the whole sample.

2.4 MODEL-PROTOTYPE CORRELATION

An effect called the "depth effect" whereby an increase in modulus of elasticity and decrease in modulus of rupture accompany an increase in beam depth is usually observed[10] in timber. Therefore the mean grading modulus of the model boards should be less than the mean grading modulus of the prototype boards from which they were cut. However, figure 2.6 shows

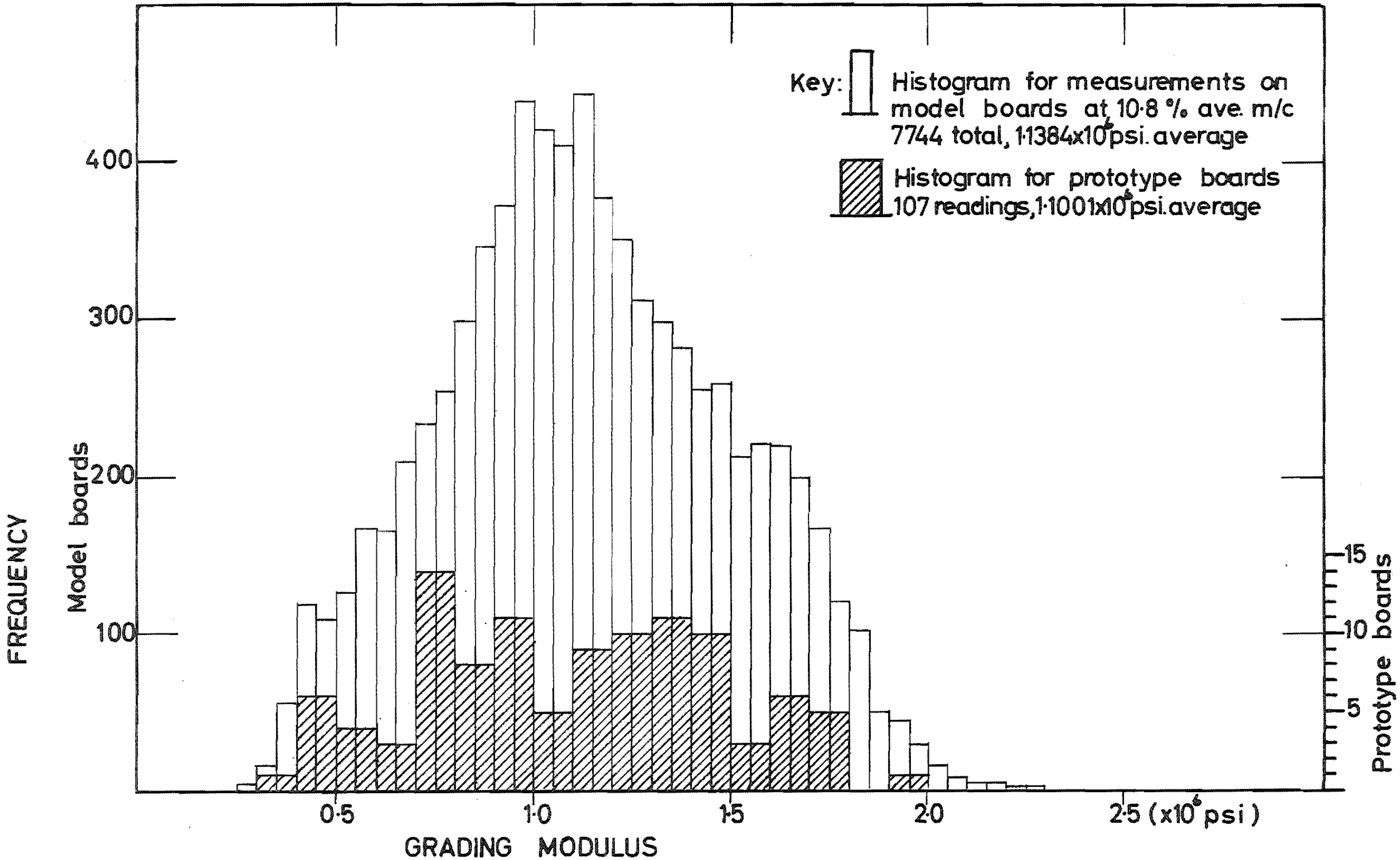


FIG. 2.6 Frequency distribution of grading modulus measurements on model boards andof those prototype boards from which the model boards were cut.

that the average moduli for the model and prototype boards are 1.138 and 1.100 X 10^6 psi respectively.

To investigate this effect 21 prototype boards, 37 in. long, were selected free from visible defects over their central 12 in. and measured for grading modulus. Each was cut into eleven model boards as described previously and the modulus of the model boards was determined at the same point as in the parent prototype boards. The resulting correlation is shown in figure 2.7. Again the mean model values were higher than the prototype values but, with such a large scatter present from differences between earlywood and latewood bands, a larger sample would be necessary to make statistically significant conclusions.

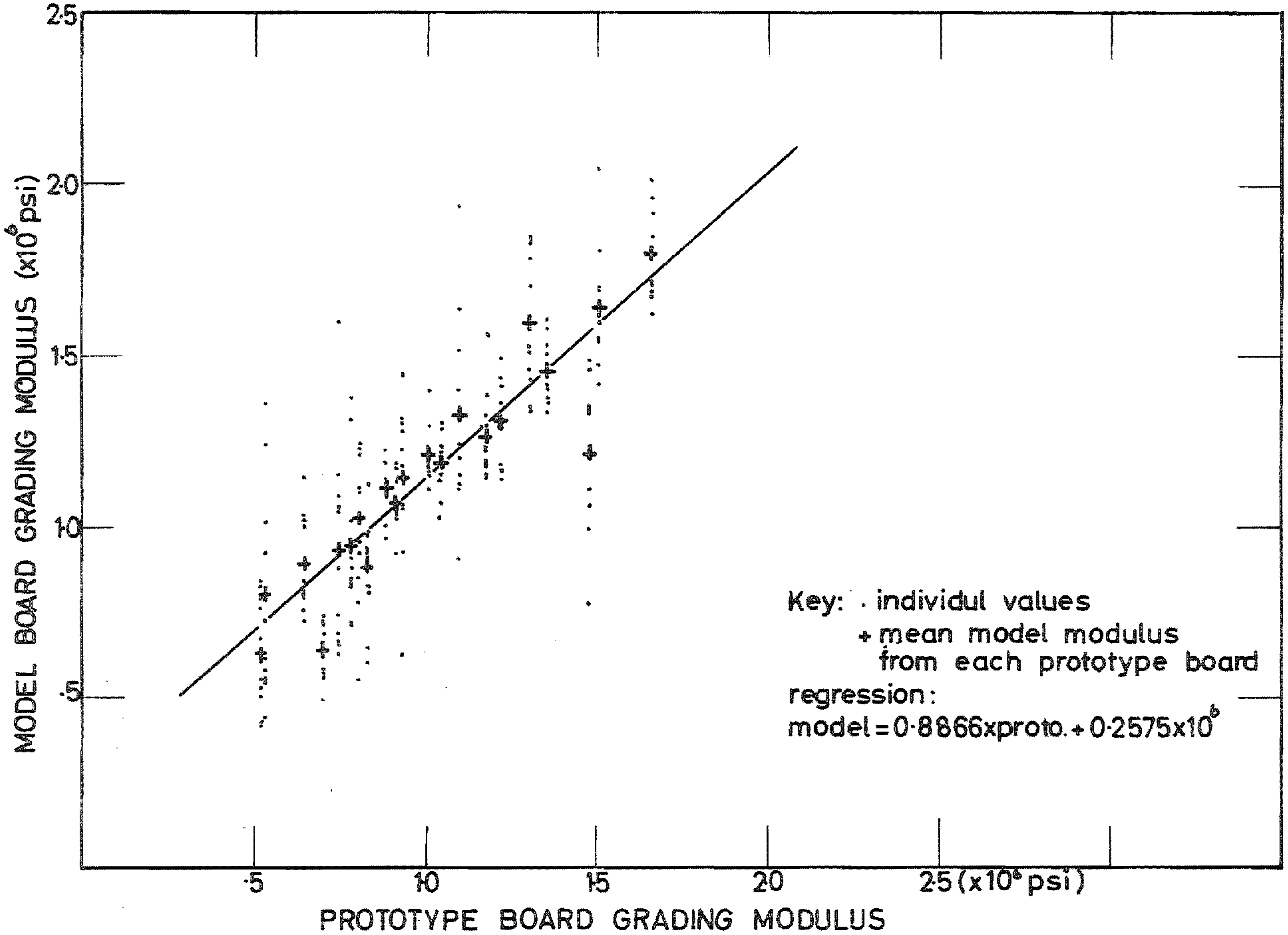


FIG. 2.7 Plot of grading modulus of prototype boards against grading modulus of model boards cut from them.

CHAPTER THREE

PROPERTIES OF RADIATA PINE

Small, clear, air-dry specimens were tested according to the 2 cm standard methods[11] in order to describe the timber and relate its properties to grading modulus.

3.1 EXPERIMENTAL INVESTIGATIONS

3.1.1 Specimen Preparation

From the stacked prototype boards, 50 pieces each 37 in. long were selected. These were free of visible defects and contained a 12 in. mid-length portion with a grain slope less than 1 in 20. Two pieces were later discarded due to excessive grain slope. A wide range of grading modulus was sought as the results were to be correlated against this property.

The selected pieces were fillet-stacked for two weeks in a constant temperature room with controlled atmosphere of 68 $\pm$ 2°F and 57 $\pm$ 2% r.h., and then retested for grading modulus. The central 12 in. lengths were then cut out and the 2 cm square specimens cut from these while the offcut lengths were retained for fabrication into nailed joints. Both specimens and offcuts were returned to the constant temperature room for a further three weeks before trimming to length and testing.

3.1.2 Experimental Procedure

The specimens were tested on a 25,000 lb Avery universal testing machine according to the 2 cm standard methods for:

(a) Static bending

(b) Compression parallel to the grain, and

(c) shear parallel to the grain. Also a test method for

(d) compression perpendicular to the grain was devised by scaling the standard method for 2 in. cube specimens.

In detail these methods are as follows:

(a) Static bending: 2 X 2 X 30 cm specimens were simply supported over a 28 cm span in the apparatus shown in figure 3.1 and loaded centrally with a single point load. No attention was paid to the orientation of the annual rings but the specimens were loaded in the same direction as they had been in the prototype board when being tested for grading modulus. The central deflection was assumed to be equal to the relative movement of the machine platens which was recorded on the automatic load-deformation recorder of the machine. The required rate of deformation of 0.26 in./min. was obtained by manually adjusting the rate of oil flow and observing the movement of the automatic recorder.

(b) Compression parallel to the grain: 2 X 2 X 6 cm specimens were tested in the cage shown in figure 3.2.

(c) Shear parallel to the grain: 2 cm cube specimens were tested in the apparatus shown in figure 3.3.

(d) Compression perpendicular to the grain: 2 cm cube specimens were tested in the apparatus shown in fugure 3.3 at a rate of deformation of 0.01 in./min. with the load being applied in the direction of the thickness of the parent prototype board.

The specimens were removed from the controlled atmosphere a few at a

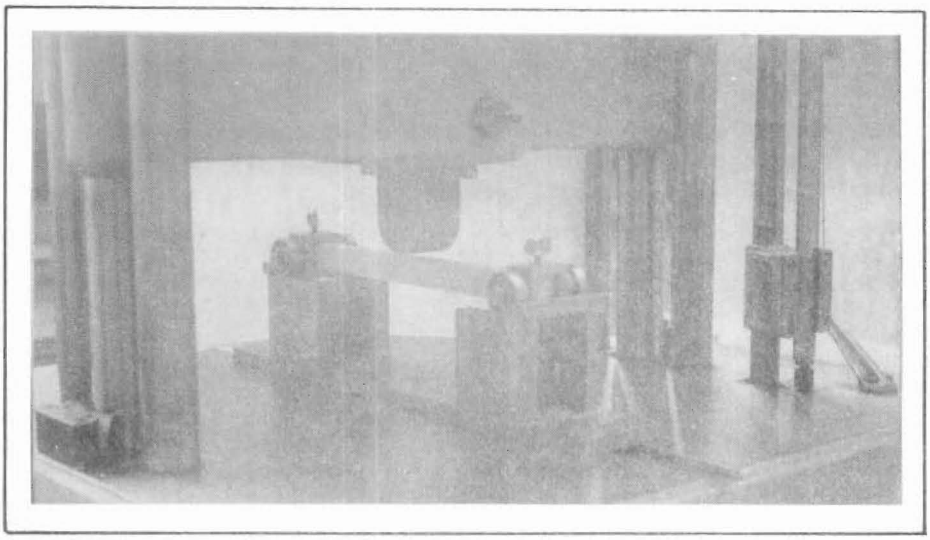


FIG. 3.1. Standard 2 cm. static bending test.

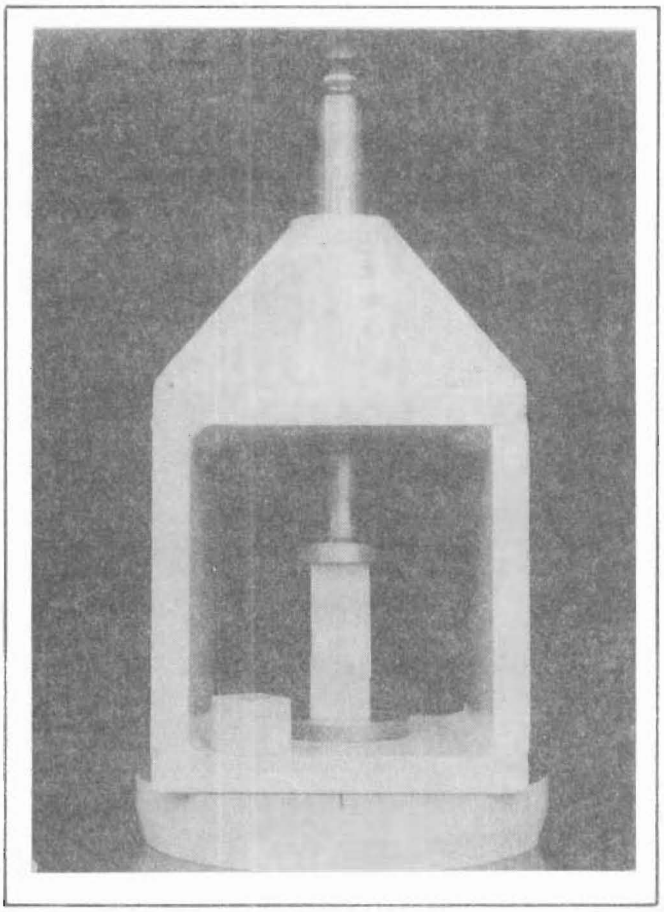


FIG. 3.2. Cage used for parallel- and perpendicular-to-grain compression tests.

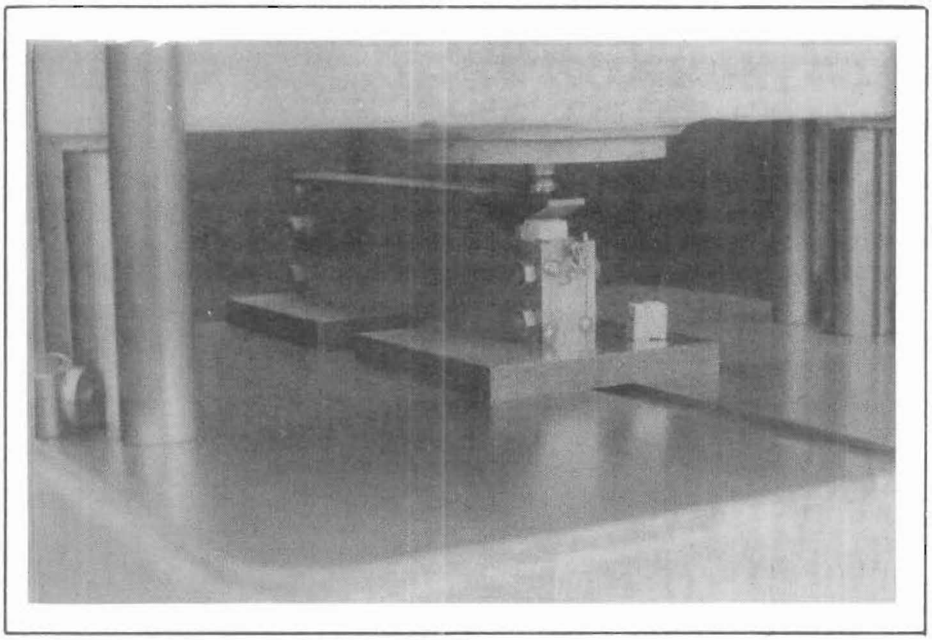


FIG. 3.3. Apparatus for 2cm. standard shear parallel to grain test.

time as the laboratory conditions were in the range 68–72°F and 58–68% r.h. Immediately after testing each specimen was weighed and oven dried.

3.2 RESULTS

3.2.1 Data Processing

(a) Static bending: values for modulus of elasticity (MOE) and modulus of rupture (MOR) were calculated from the automatically recorded load deformation graphs and the measured specimen dimensions.

(b) Compression parallel to the grain: the fibre stress at maximum load, the nominal density, (oven dry weight)/(volume at specified moisture content), and the moisture content were calculated.

(c) Shear parallel to the grain: fibre stress at maximum load, nominal density and moisture content were calculated.

(d) Compression perpendicular to the grain: the fibre stress at proportional limit and moisture content were calculated.

The grading modulus values were adjusted to apply to 12% moisture content according to figure 2.4 while the strength values were adjusted by the following equation given by Wangaard[12]:

$$\text{Log } S_D = \text{Log } S_C + \frac{(C - D)}{(A - B)} \text{ Log } \frac{S_A}{S_B}$$

where A = fibre saturation moisture content (28%)

B = air dry moisture content (12%)

C = moisture content at test

D = adjusted moisture content (12% in this case)

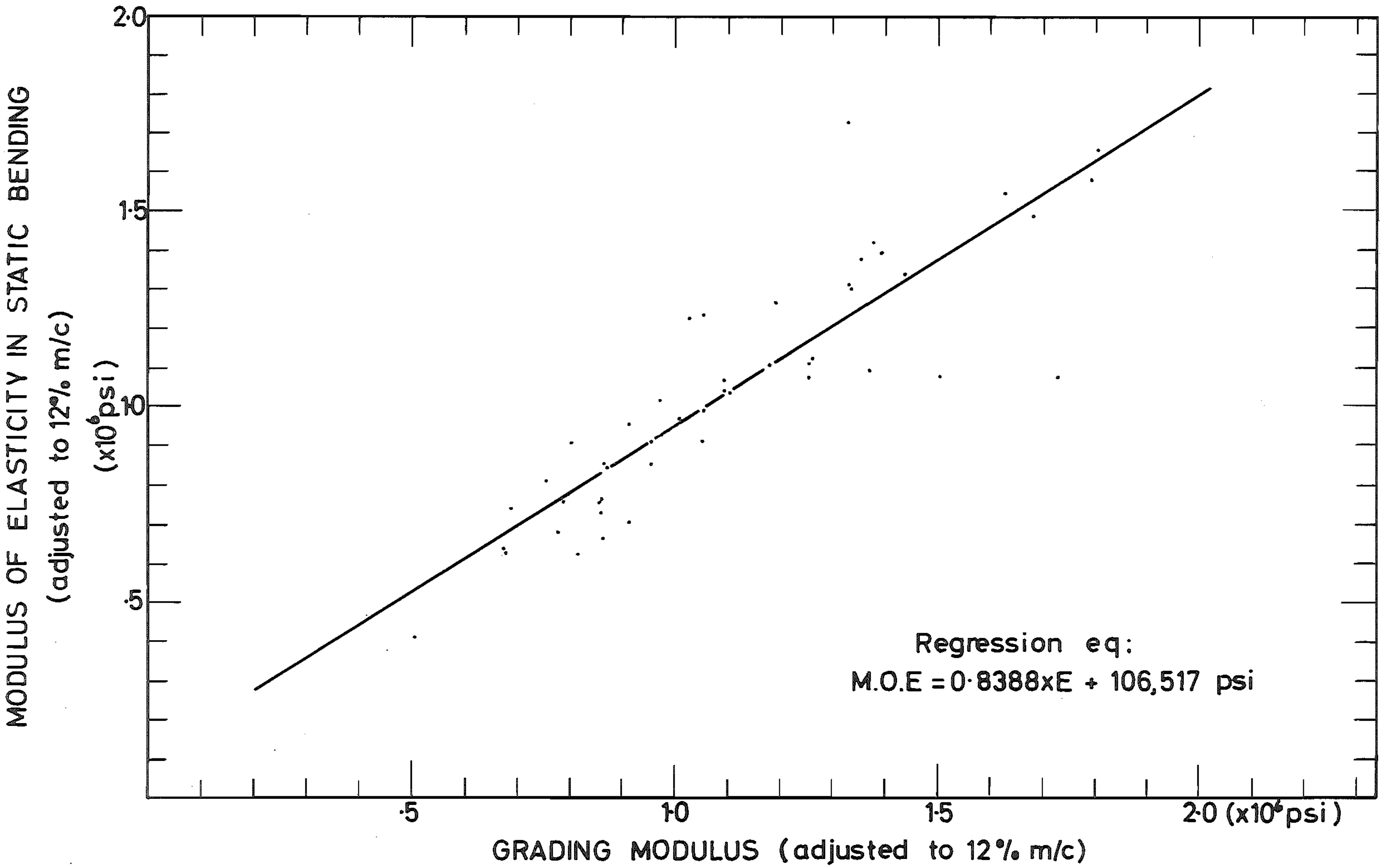


FIG. 3·4 Plot of modulus of elasticity in static bending against grading modulus at 12% moisture content

S_A, S_B = species mean strength values at green and air dry conditions respectively

S_C = strength value at test

S_D = adjusted strength value

The adjustment amounted to about 2% in most cases. The values obtained are shown plotted against grading modulus in figures 3.5 to 3.9.

3.2.2 Correlation with Grading Modulus

The regression equations obtained by the method of least squares are given in table 3.1.

TABLE 3.1 Correlation of properties at 12% m.c. against grading modulus

PROPERTY	REGRESSION COEFFICIENTS IN PROPERTY = M X E + C		CORRELATION COEFFICIENT
	M	C	r
MOE	.8388	106,520 psi	.877***
MOR	.00539	4,316 "	.790***
Max. stress compr. //*	.00264	2,035 "	.869***
Max. stress shear //	.000353	1,103 "	.445***
Propl. limit stress compr. 1**	.000117	697 "	.230
Nominal density	.00000473	17.87 lb/cu ft	.600***

* // means parallel to grain

** 1 means perpendicular to grain

*** significant at the 1% level of probability

3.2.3 Comparison With Published Data

Referring to figure 2.4, the mean grading modulus of defect-free prototype boards was 1.077 X 10^6 psi at 10.7% moisture content which becomes

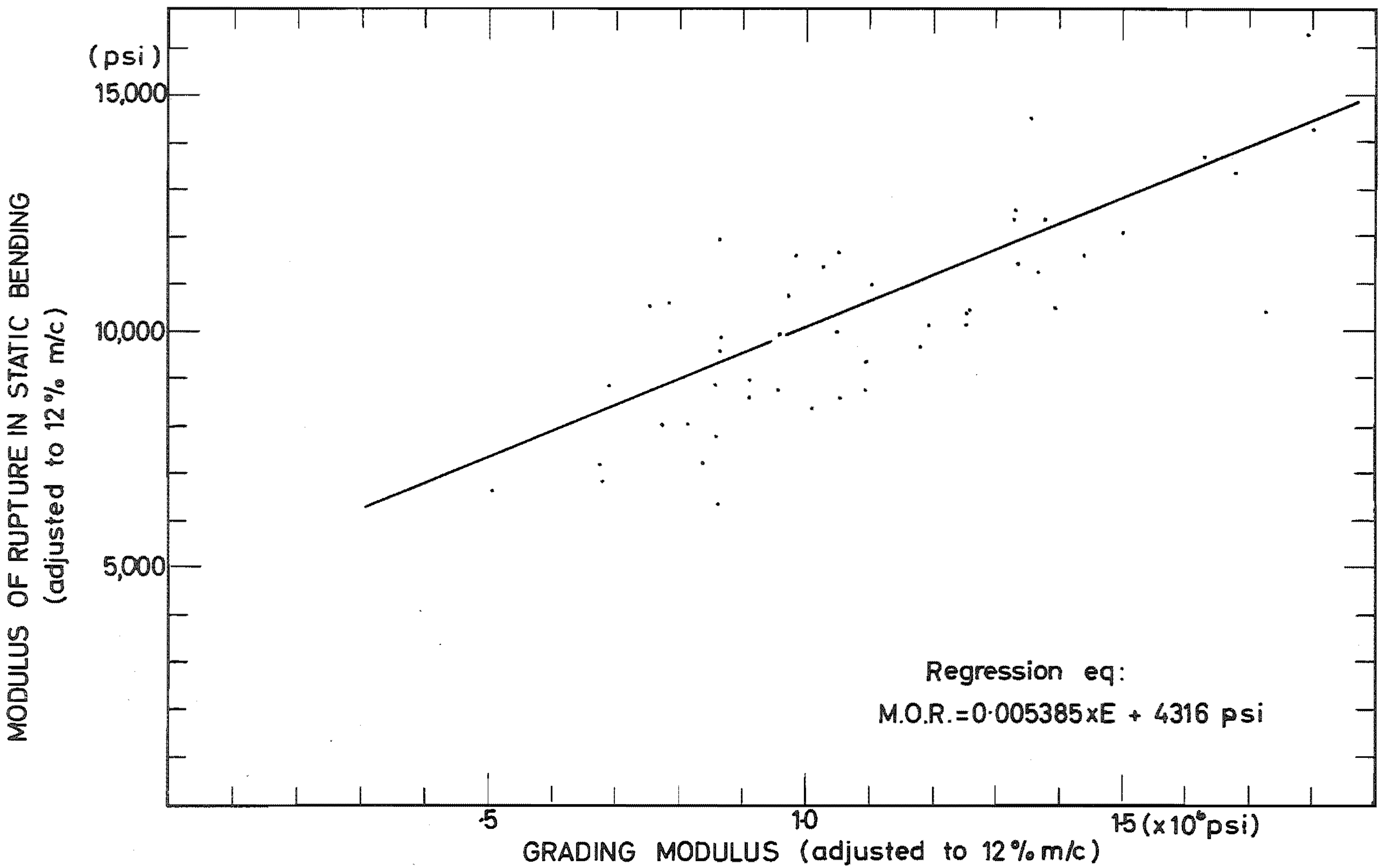


FIG.3.5. Plot of modulus of rupture in static bending against grading modulus at 12% moisture content.

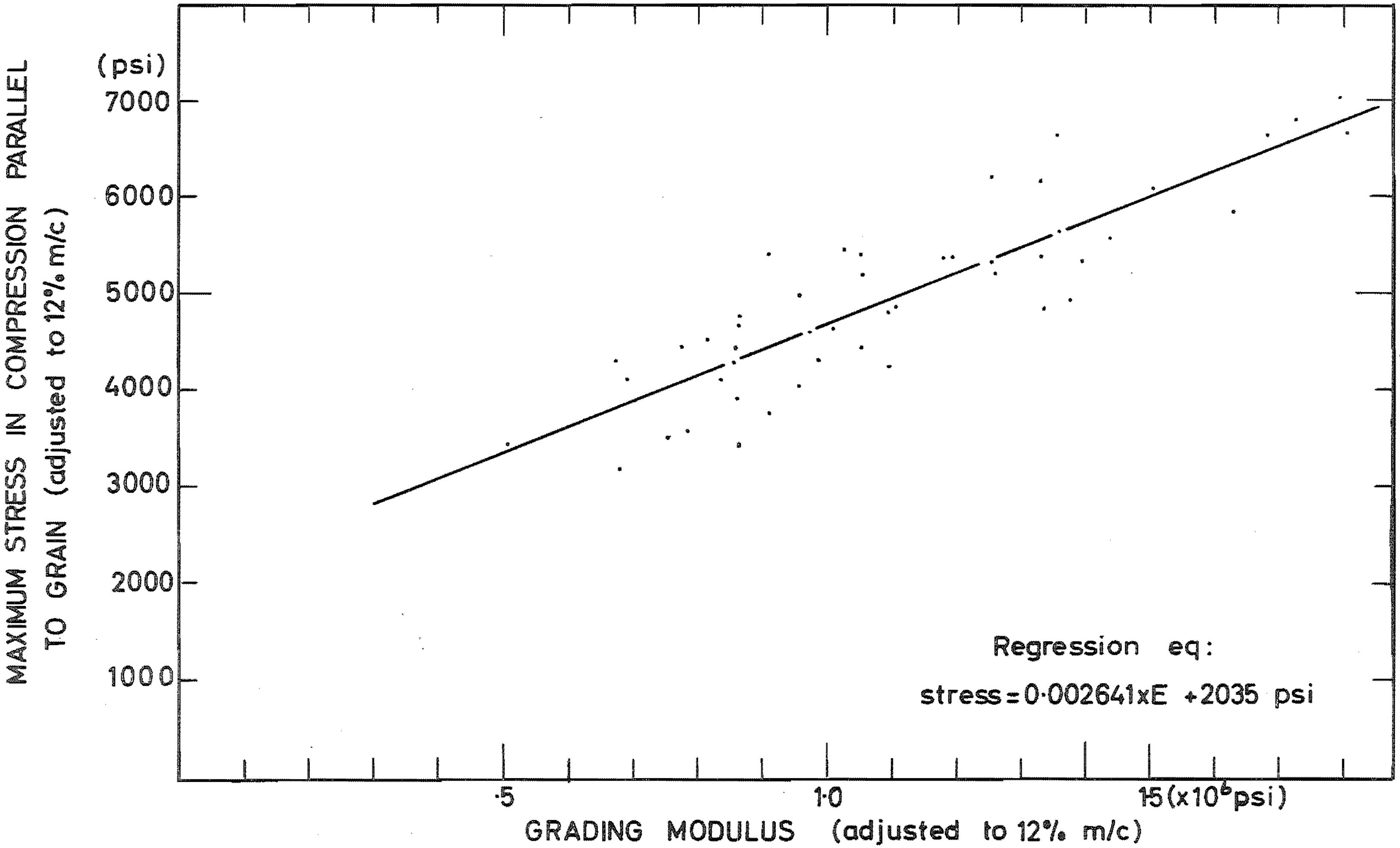


FIG.3.6. Plot of maximum stress in compression parallel to grain against grading modulus at 12% moisture content.

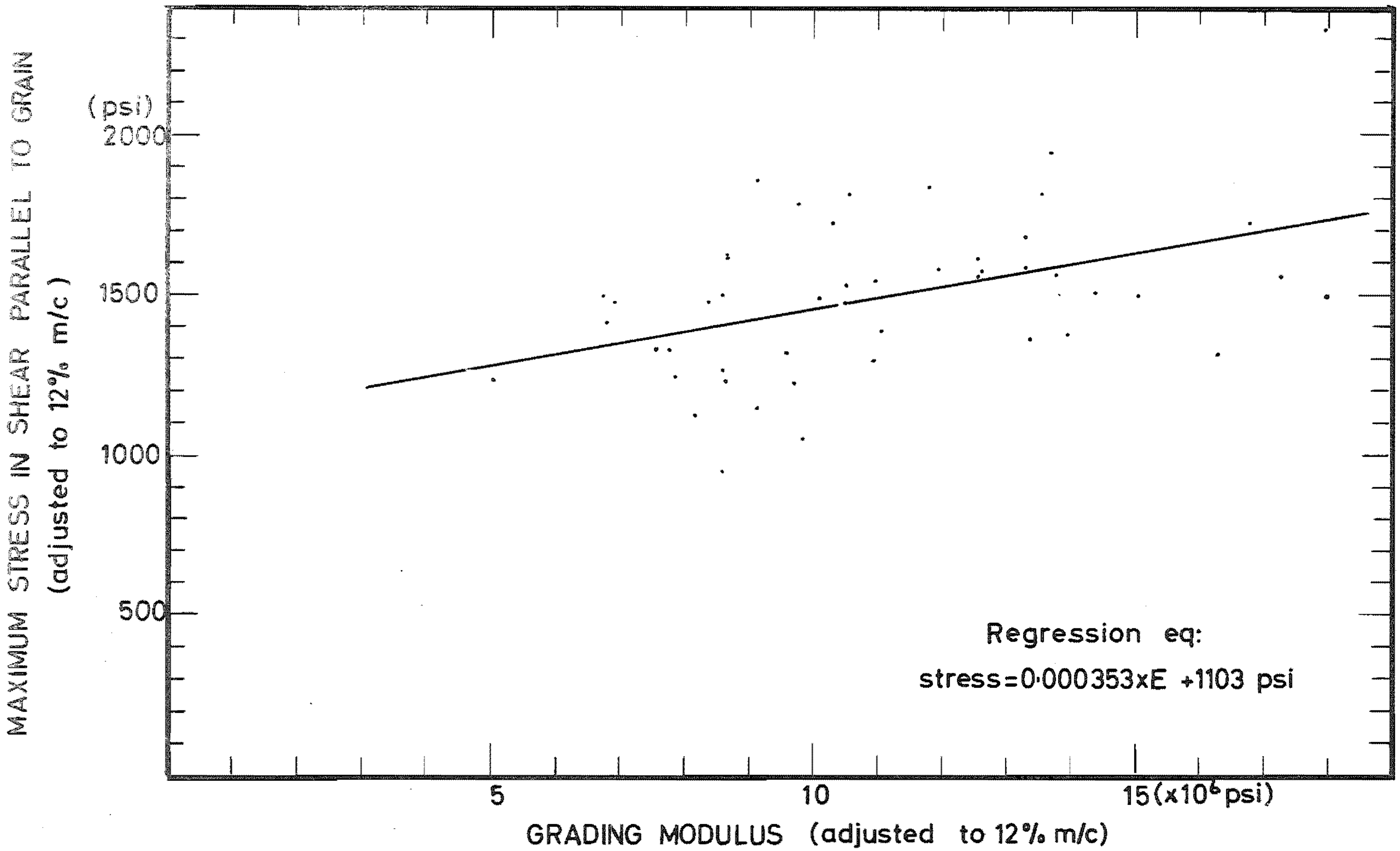


FIG. 3.7 Plot of maximum stress in shear parallel to grain against grading modulus at 12% moisture content.

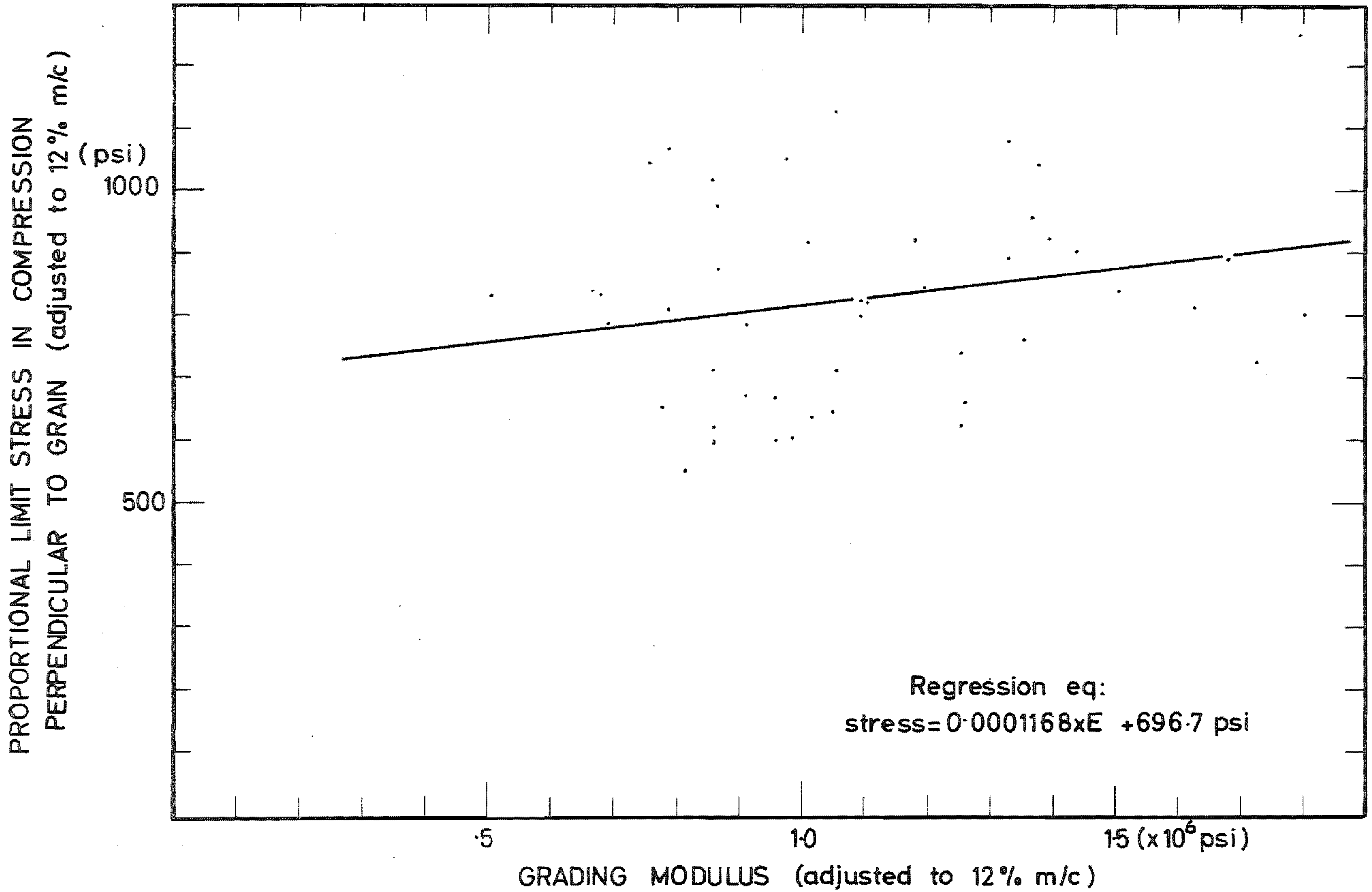


FIG.3.8. Plot of proportional limit stress in compression perpendicular to grain against grading modulus at 12% moisture content.

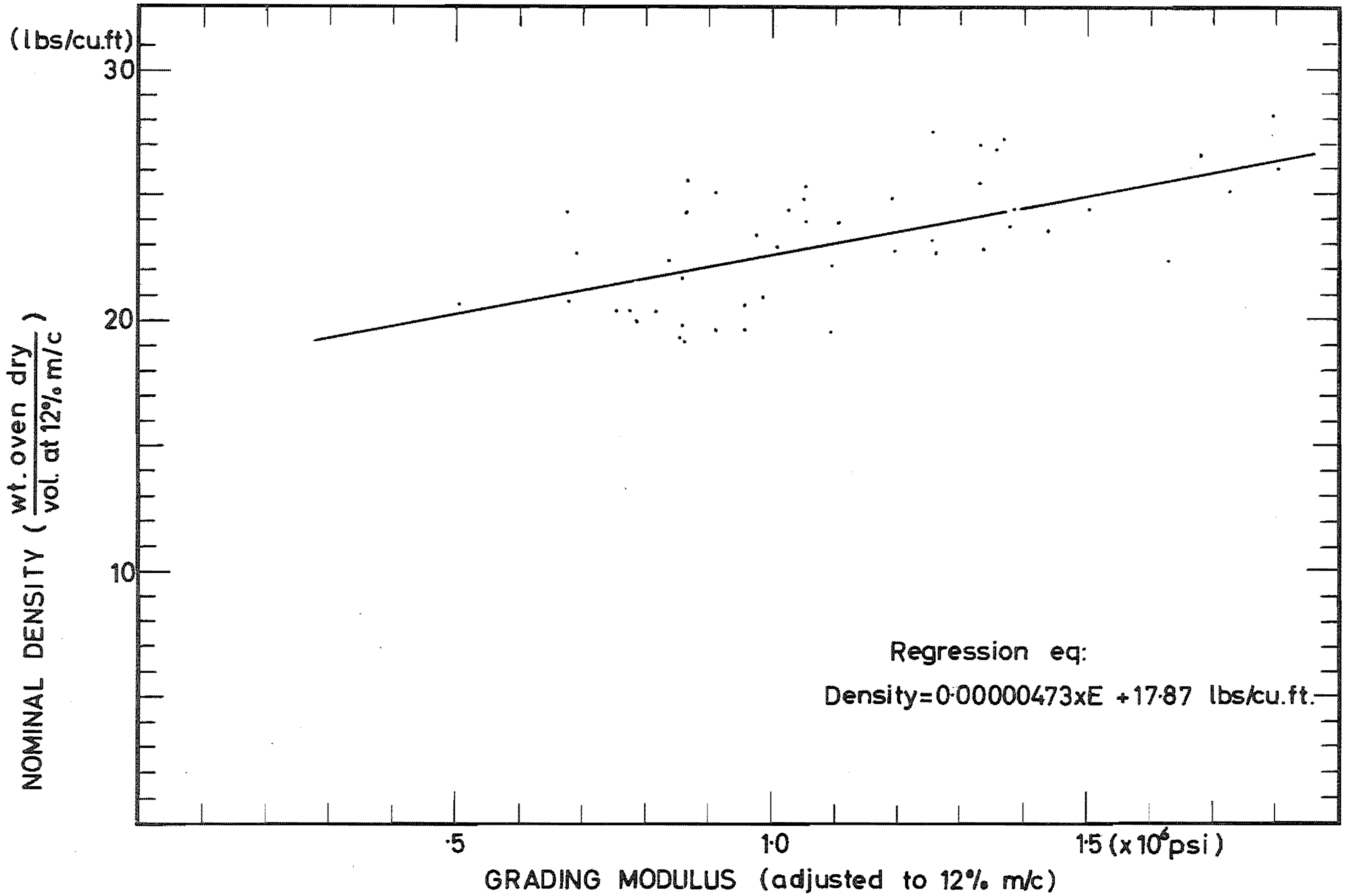


FIG.3.9. Plot of nominal density against grading modulus at 12% moisture content.

1.051×10^6 psi at 12% according to figure 2.5. Since the standard strength values also refer to defect-free timber, this value of grading modulus has been substituted into the equations in table 3.1 to give the data in table 3.2. It is seen from this table that the radiata used averaged about 10% weaker and about 40% more flexible than that from other sources. The 2 in. and 2 cm standards are not directly comparable, however, due to a scale effect. The ratios, 2 in./2 cm, of the mean values for a large number of species have been calculated(13) and found to be 1.07, 0.95, 0.96 and 0.88 for MOE, MOR, compression // grain and shear // grain respectively. However, considering the variation in these properties and the good correlation with grading modulus obtained, especially for MOE, MOR and compressive strength parallel to grain, it is possible to select material representative of that from other sources.

TABLE 3.2 Comparison of mean mechanical properties of small, clear specimens of a selection of structural timbers (with radiata) at 12% m.c.

SPECIES AND SOURCE	NOMINAL DENSITY (DRY WT:VOL. AT 12%)	MODULUS OF ELASTICITY	MODULUS OF RUPTURE	COMPRESSIVE STRENGTH // GRAIN	SHEAR STRENGTH // GRAIN	COMPRESSIVE STRESS AT PROPORTIONAL LIMIT ⊥ GRAIN	TESTING STANDARD	REFERENCE
UNIT	1lb/cu ft	$X10^6$psi	psi	psi	psi	psi		
Radiata (Burwood)	23	0.988	9,976	4,810	1,474	820	2 cm	*
Radiata (Rotorua)	28	1.320	11,010	5,900	1,550	860	2 in.	(14)
Radiata (Australia)	32	1.650	11,600	6,080	1,600	820	2 in.	(15)
Radiata (Chile)	31	1.370	10,520	6,000	1,350	920	2 in.	(16)
Douglas fir (USA)	30	1.920	11,700	7,420	1,140	910	2 in.	(12)
Douglas fir (Rotorua)	34	1.950	14,150	7,890	1,120	1,040	2 in.	(17)
Red cedar (Canada)	21	1.120	7,700	5,020	860	610	2 in.	(12)
Sitka spruce (USA)	25	1.570	10,200	5,610	1,150	710	2 in.	(12)

* data from material used in this study

CHAPTER FOUR

FASTENING PROPERTIES

In order to determine the properties of the various means of fastening the layers, joints representative of those used in the prototype and model shell elements were tested and their load-slip curves fitted to empirically-derived mathematical expressions.

4.1 LITERATURE SURVEY

4.1.1 Nailed Joints

Nailed timber joints have been studied for many years, mainly for the purpose of specifying design loads in codes of building practice. Initially, with attention confined to the ultimate strength of the joint, a reasonably accurate theory was developed in 1951 by Möller(18) and extended in 1957 by Meyer(19) to the point where the predicted strength was within 5% of the experimental strength. Some recognition of the load-slip characteristics of nailed joints is given by American building codes where the recommended loads are based on the load required to produce an arbitrary slip of 0.015 in. However, the possibility that the slip in a nailed joint may be more important than its ultimate strength in terms of the deformation of a total structure has been investigated by Granholm(20) in his 1949 study of the collapse of the formwork for the concrete arch of the Sandö bridge and more lately by the many researchers on trussed rafters. Detailed theoretical study in 1955 by Jansson(21) produced formulae, involving variables to describe the nail and the wood, which fitted experimental data well above slips of about 0.01 in. They were, however, cumbersome formulae and much simpler but similar expressions were derived empirically in 1966 by Mack(22).

These gave very good fit with experimental data even for a variety of species and sizes of joint. His method appears to be very useful for describing load-slip characteristics. Many factors affect the load- slip and ultimate strength behaviour of nailed joints including

Moisture content

Number of nails

Type of nail

Friction between members

Duration of loading

Grain orientation, etc.,

all of which have received more or less attention. As these factors do not enter into this study as variables work in these fields will not be reviewed except to mention that Hellawell[23] concluded that: "the joints with grooved nails are initially much less stiff, but ultimately about 60% stronger than those with plain nails" in his work on dry radiata pine joints.

The methods of testing used by the various workers usually differ according to the objects of the study and the equipment available. The method most suitable for the objects of this study is that proposed by Vermeyden[24] and used by Lee[2]. It is described in section 4.2.2.

4.1.2 Nail-Glued Joints

The nail-glued inter-layer connection in timber shell roofs may be typified by joints such as occur in nail-glued timber trusses although in a shell the nails are required to hold the boards in a curved shape as well as to provide gluing pressure. Research on nail-glued timber truss joints has been undertaken in most parts of the world and the findings of Moe[26] that glueline shear strengths from 100 to 500 psi may be expected in the joints of trusses fabricated from Norway spruce at 20% m.c. using casein glue and 10-12 nails/sq ft of glued area, are typical for structural softwoods. Although timber shell gluelines are likely to be weaker than timber truss gluelines, Booth[4] states that: "the function of the adhesive is mainly to increase the stiffness of the membrane rather than transfer high shear stresses."

It follows then, that although the assembly conditions preclude high strength of the glue line, the strength obtained should be adequate even when lower nailing densities than those recommended by Moe are used.

The deformations occurring in the glueline of nail-glued joints are considered to be zero below failure with the observed joint deformation arising from strains in the jointed members themselves. Therefore in describing the properties of nail-glued joints, it appears that ultimate strength is the only pertinent property.

4.2 PROTOTYPE JOINTS

4.2.1 Preparation

The 96, twelve-inch-long offuct pieces of T & G mentioned in section 3.1.1 were fabricated into nailed joints using two $1\frac{1}{2}$ in. by 14 s.w.g. plain nails and two $2\frac{1}{4}$ in. by 11 s.w.g. annularly grooved shank nails as shown in figure 4.1.

At each grading modulus value two nailed joints were fabricated, one to be tested with the load //, ⊥ and // to the grain of the three members, the other with the load ⊥, // and ⊥. These were fabricated in a jig in the constant temperature room using a 16 oz hammer.

Glued joints were obtained by cutting up the nail-glued 5 ft square prototype torsion elements after these had been tested as described in

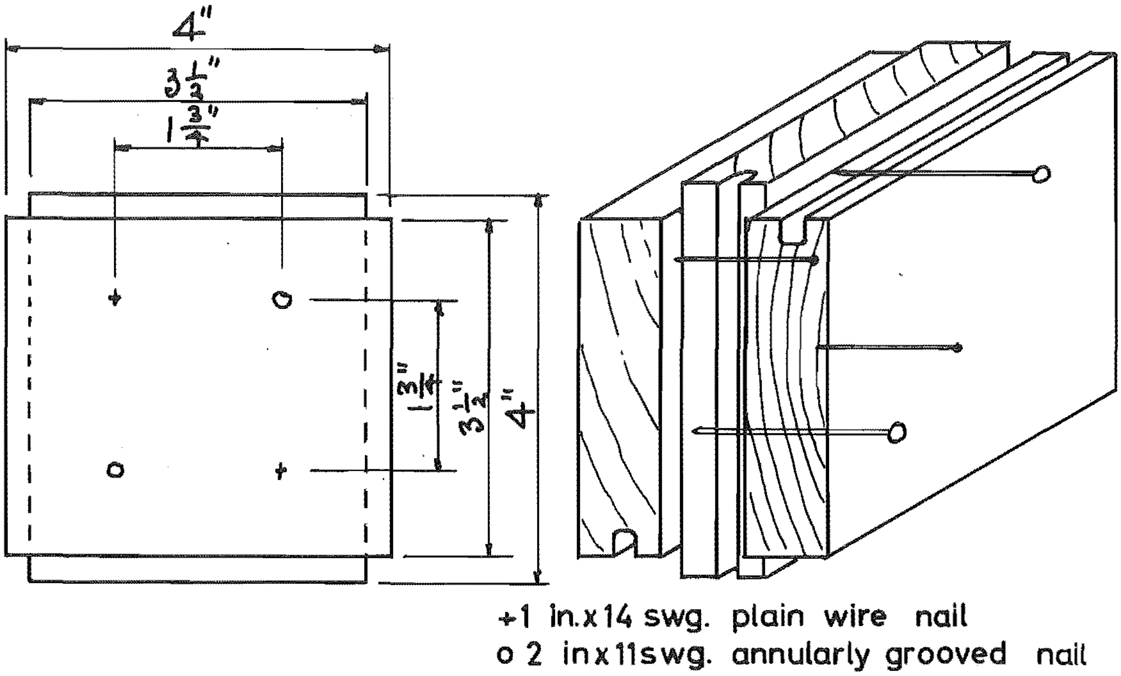


FIG. 4.1. Prototype nailed joints.

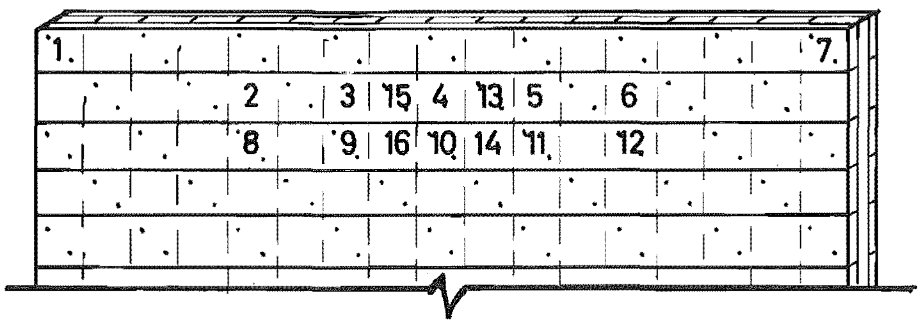


FIG.4.2. Cutting pattern for nail-glued prototype joints from nail-glued torsion elements.

section 5.3.2.4.

While the previous testing may have influenced the properties of these joints, it was considered that such joints would be more representative of the inter-layer fastening than would joints constructed of small lengths of boards, as a greater gluing pressure would probably be obtained in the latter. Cutting along the board edges, the joints were obtained and numbered as shown in figure 4.2.

The joints numbered 1 and 7 served to indicate the effects of higher gluing pressure as during fabrication these elements were clamped to the jig with G-clamps at the corner. After cutting, the joints were returned to the constant temperature room for one week before testing.

4.2.2 Testing

Both the nailed and the nail-glued joints were set up on the spherical seated platen of a 25,000 lb Avery universal testing machine as shown in figure 4.3. A dial gauge was used to measure the relative movement of the machine platens. The loading procedure proposed by Vermeyden[24] was followed.

This consisted of loading the joints at a rate of 0.2 X P per minute where P is the average expected failure load. In the case of the nail-glued joints, test joint numbers 13-16 were used to determine P, while for the nailed joints separate joints were made and tested. The load-time schedule shown in figure 4.5 was followed with the dial gauge being read at each load interval of 0.1 X P.

All the glued joints were tested with the load $\perp$, // and $\perp$ to the grain of the three members since testing //, $\perp$ and // caused crushing of the centre member.

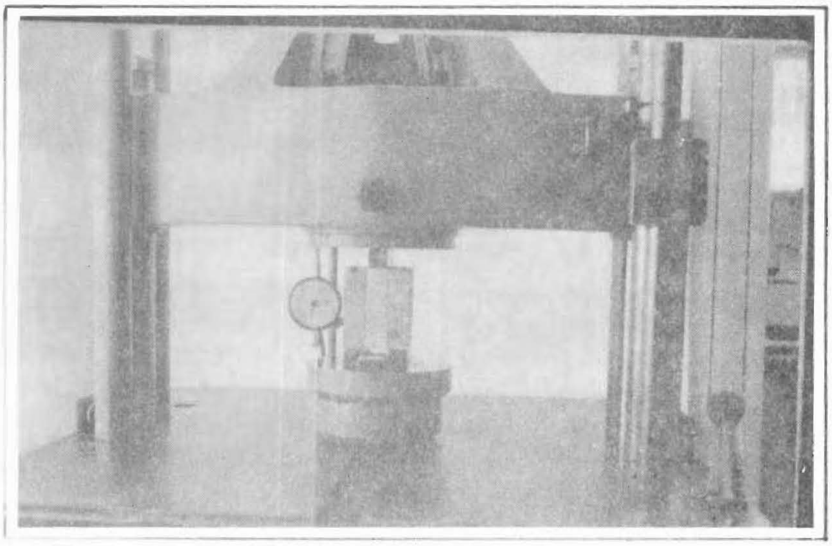


FIG. 4.3. Prototype nail-glued joint under load.

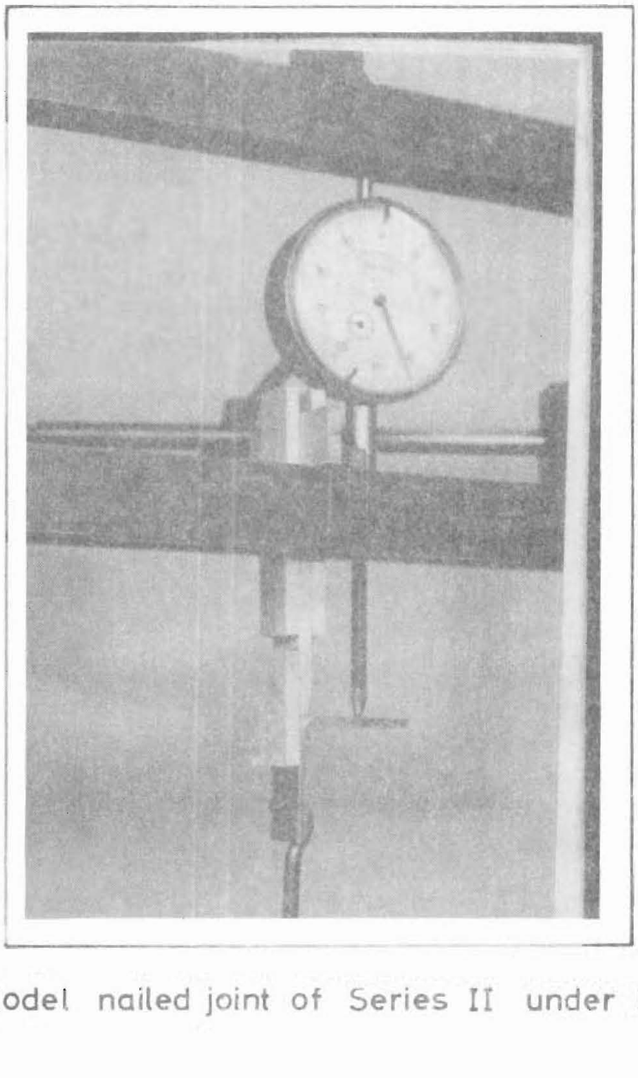


FIG. 4.4. Model nailed joint of Series II under load.

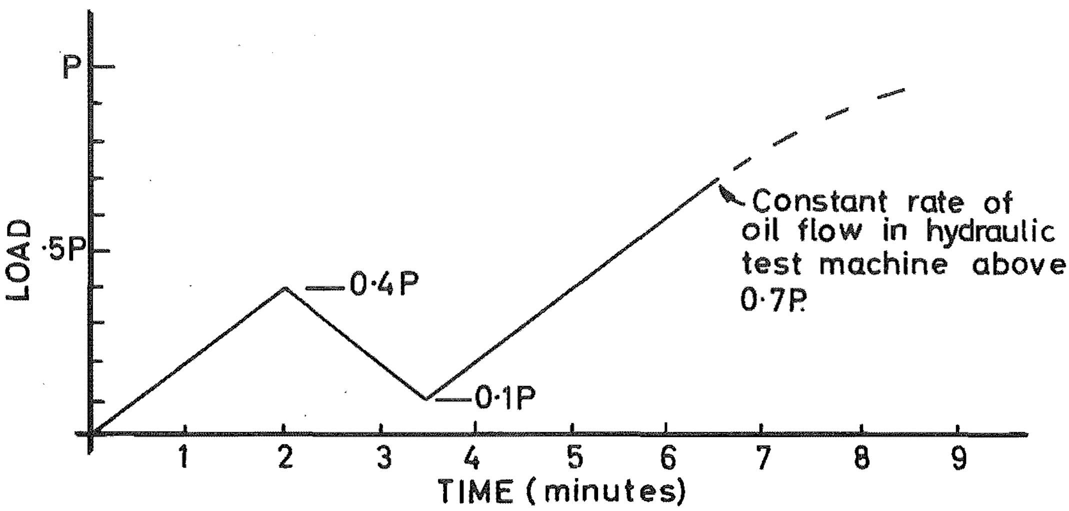


FIG.4.5. Load-time schedule for testing nailed joints proposed by Vermeyden.

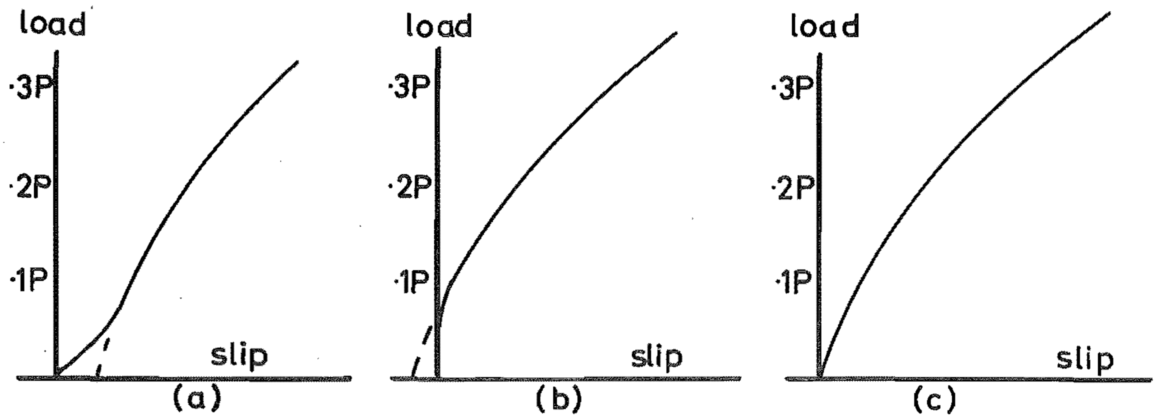


FIG.4.6. Possible initial disturbances in nailed joint load-slip curves.

4.2.3 Results

The load-deformation data for the prototype nailed joints is given in table A.1 in the appendix while data for the nail-glued joints is given in table A.2.

The mean load deformation curves for the two series of nailed joint tests are shown in figures 4.7 and 4.8 together with the extreme ranges for the individual curves and the curve for the nail-glued joints. Since the relative movement between the machine platens was observed and not the relative movement between the joint members directly, an error usually occurs in reading the dial gauge for zero load conditions as discussed by Vermeyden. This error means that initially the load-deformation curve may appear as in figure 4.6a or 4.6b instead of as in figure 4.6c which is the shape indicated by a device measuring the relative member movement directly according to work by Hellawell[23] who compared these two methods as shown in figure 4.9.

Considering this observation by Hellawell and the initial disturbance in the nail-glued joint curve in figure 4.9 it appears that this error could be entirely the result of crushing of the joint members against the machine platens. Whatever the source of this error, correction was made by extrapolating each curve as indicated by the dotted line in figures 4.7a and b to obtain an initial slip correction value which is also tabulated in table A.1. The mean grading modulus of these joints was 1.113×10^6 psi at 10.7% m.c.

4.3 MODEL JOINTS

4.3.1 Preparation

Sufficient pieces of the model boards, 2 in., 3 in., and 4 in. long were selected to make 40 each of the two types of joint shown in figure 4.10.

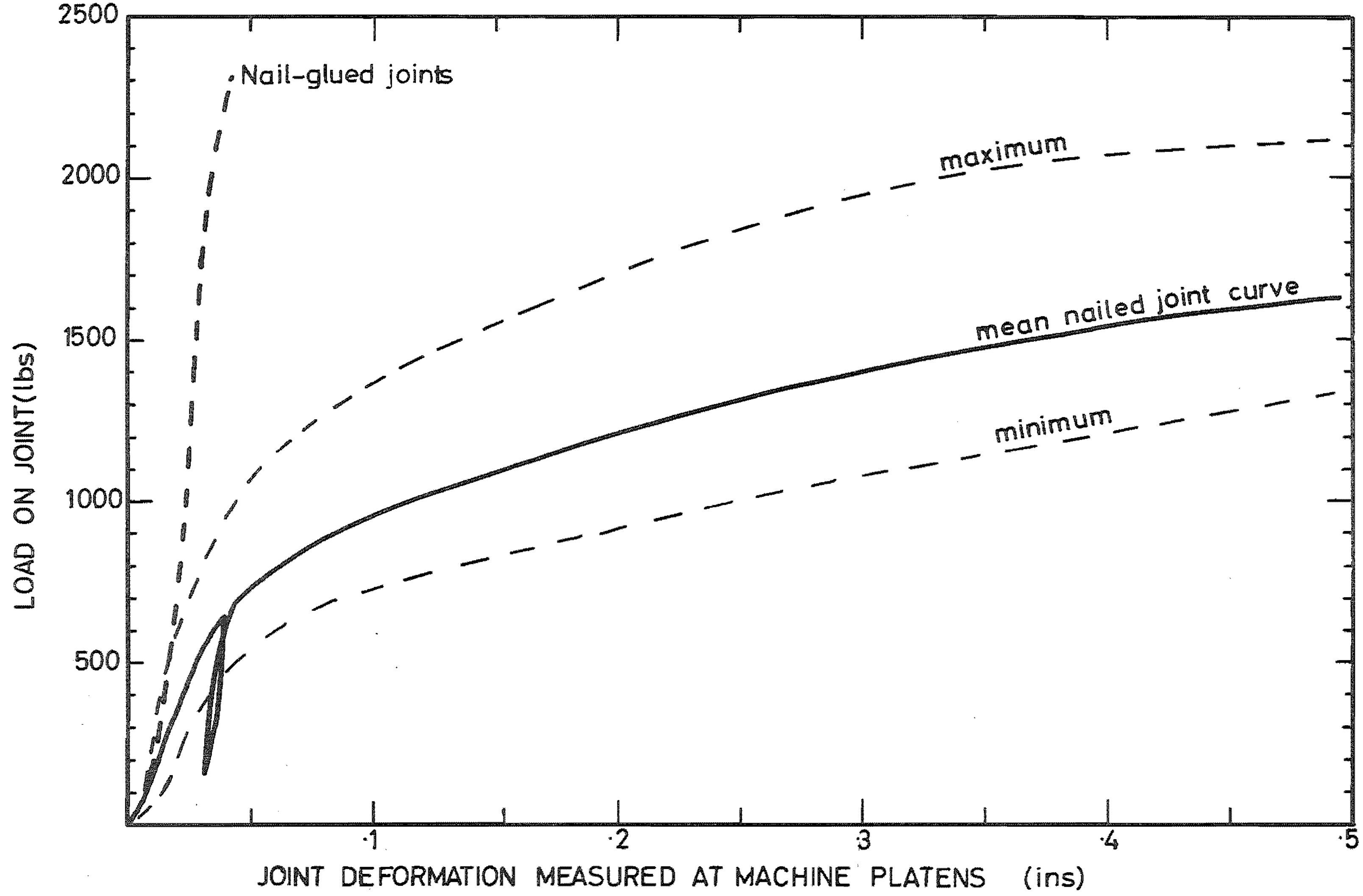


FIG.4.7. Mean load-deformation curves for nail-glued joints and Series I nailed joints. Load acting ⊥, //, and ⊥ to the grain of the three joint members respectively.

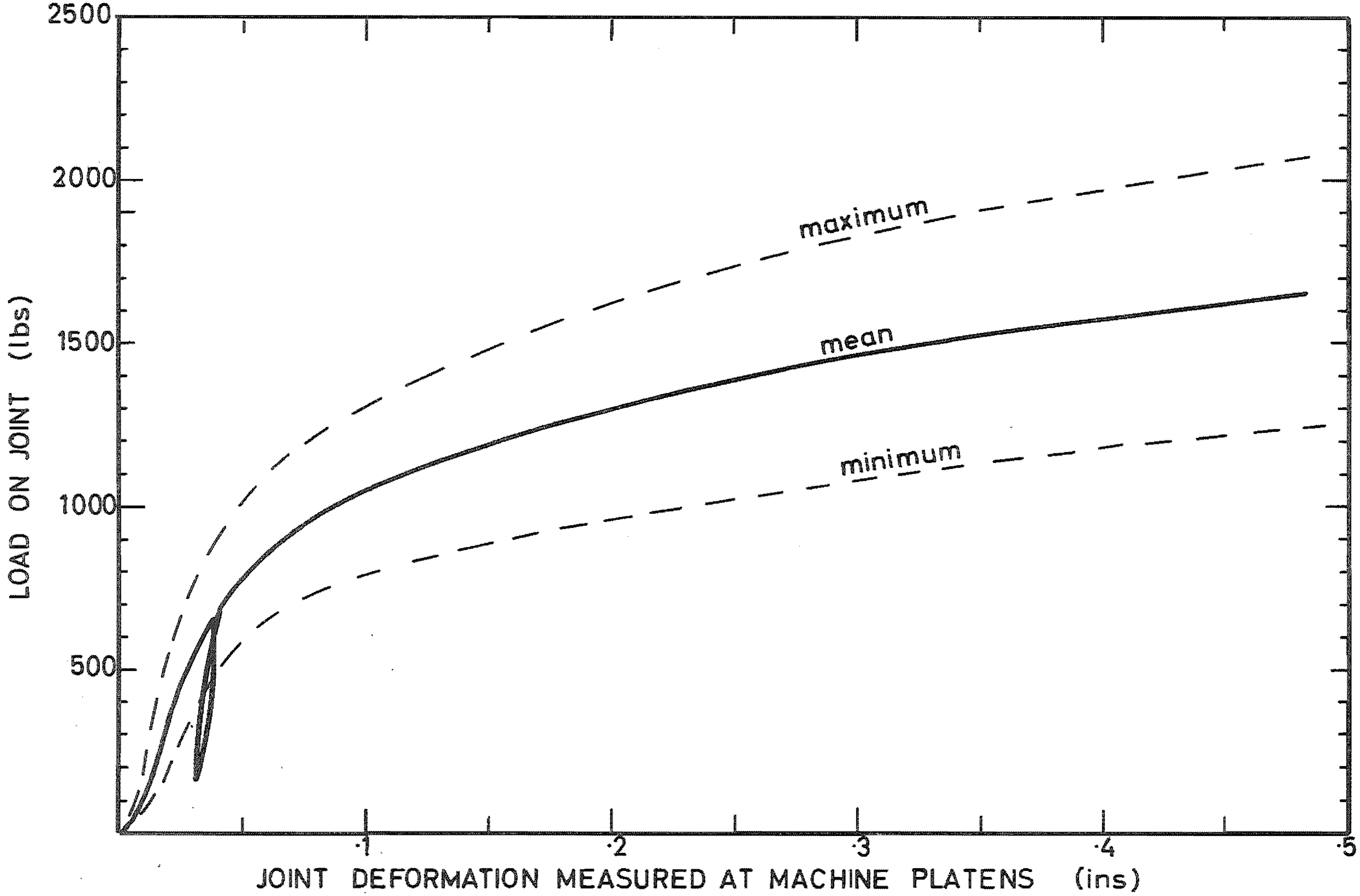


FIG.4.8. Load-deformation curves for Series II nailed joints. Load acting //, ⊥, and // to the grain of the three joint members respectively.

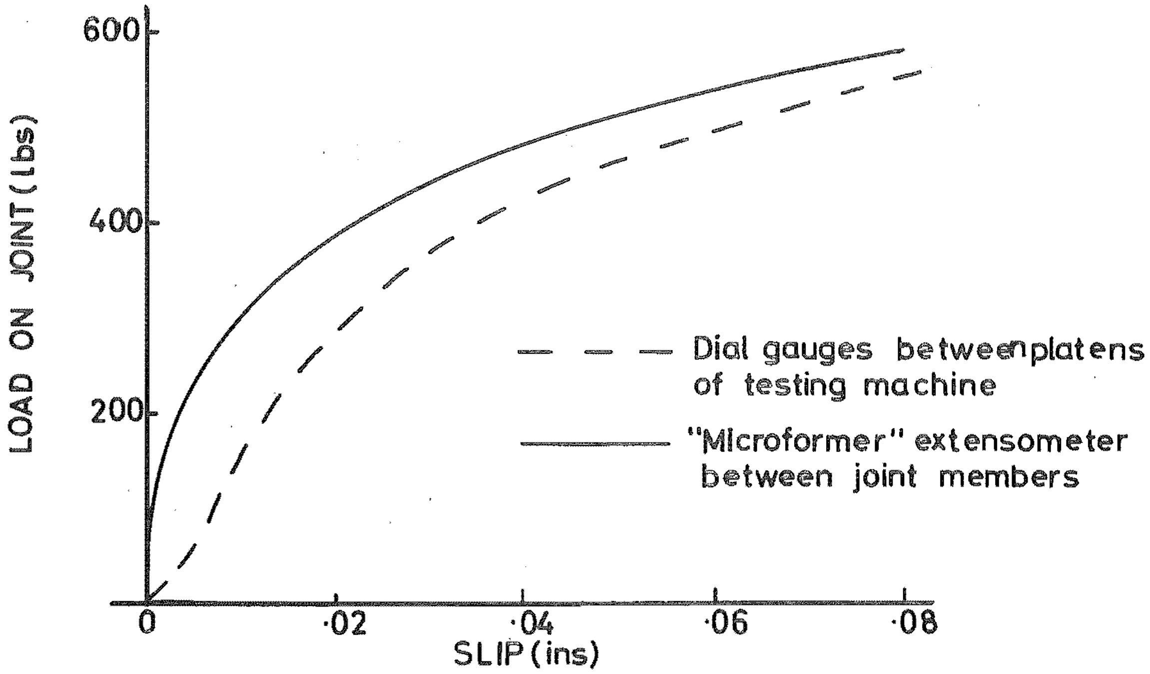
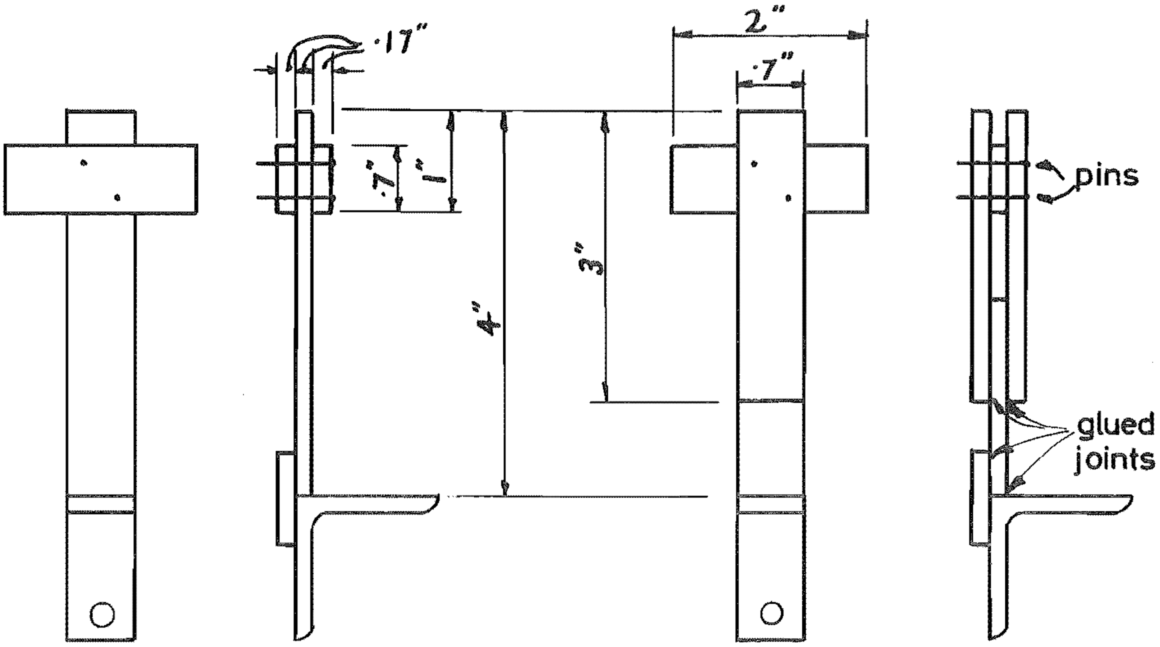


FIG.4.9. Comparative load-slip curves of two-member joints with four 2 in x 12 swg. plain wire nails in dry Radiata pine. (from Hellawell)



Series I load ⊥,//,⊥ to grain Series II load //,⊥,// to grain

FIG.4.10. Model nailed joints of dry Radiata pine and two $\frac{5}{8}$ in. stationery pins.

$\frac{5}{8}$ in. stationer's pins were used for model nails. The range of grading modulus was from 0.35 to 1.96 X 10^6 psi with a mean of 1.042 X 10^6 psi. All joints were made and tested in the constant temperature room. "Araldite" epoxy resin was used to attach the aluminium loading brackets.

4.3.2 Testing

The joints were placed across two parallel 1 X $\frac{1}{2}$ in. steel beams spaced $\frac{3}{4}$ in. apart as shown in figure 4.4.

Load was applied through a lever system and a link to the aluminium bracket. The incremental load-time schedule as shown in figure 4.11 was used with increments of 6.5 lb obtained by placing 1 lb weights on the load pan of the 6.5:1 lever system.

A vibrator attached to the frame of the loading rig was effective in overcoming frictional effects in the dial gauge and lever system. The dial gauge was read at 30 sec. intervals just before each load change with the first reading taken at a load of 0.1 P. After testing, the aluminium bracket and that portion of the joint containing epoxy adhesive was broken off and a moisture content determination made of the remainder. The mean moisture content was 10.6% and the mean grading modulus value was 1.042 X 10^6 psi for these joints.

4.3.3 Results

The load deformation data for the model nailed joints which are given in table A.3 in the appendix were corrected in the same manner as the prototype joints in that extrapolation back to the zero load level was made to obtain an initial slip correction value. This value was always negative as the first reading of the dial gauge was taken at a load of 6.5 lb. Figures 4.12 and 4.13 show the mean and range of load-deformation behaviour observed in the two types of model nailed joints.

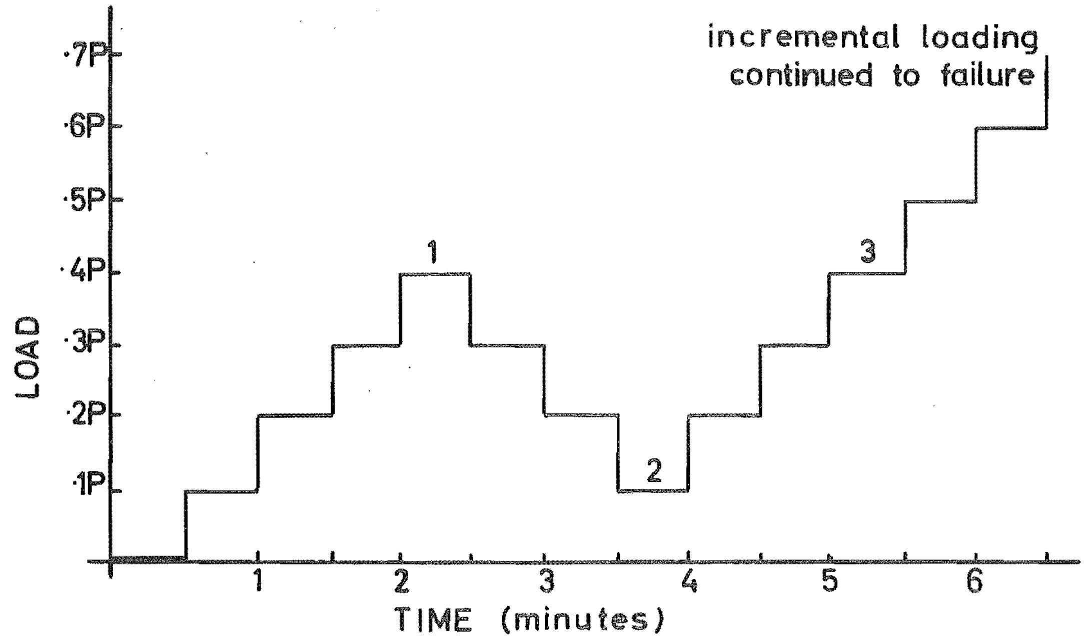


FIG.4.11. Incremental load-time schedule used in model nailed joint tests.

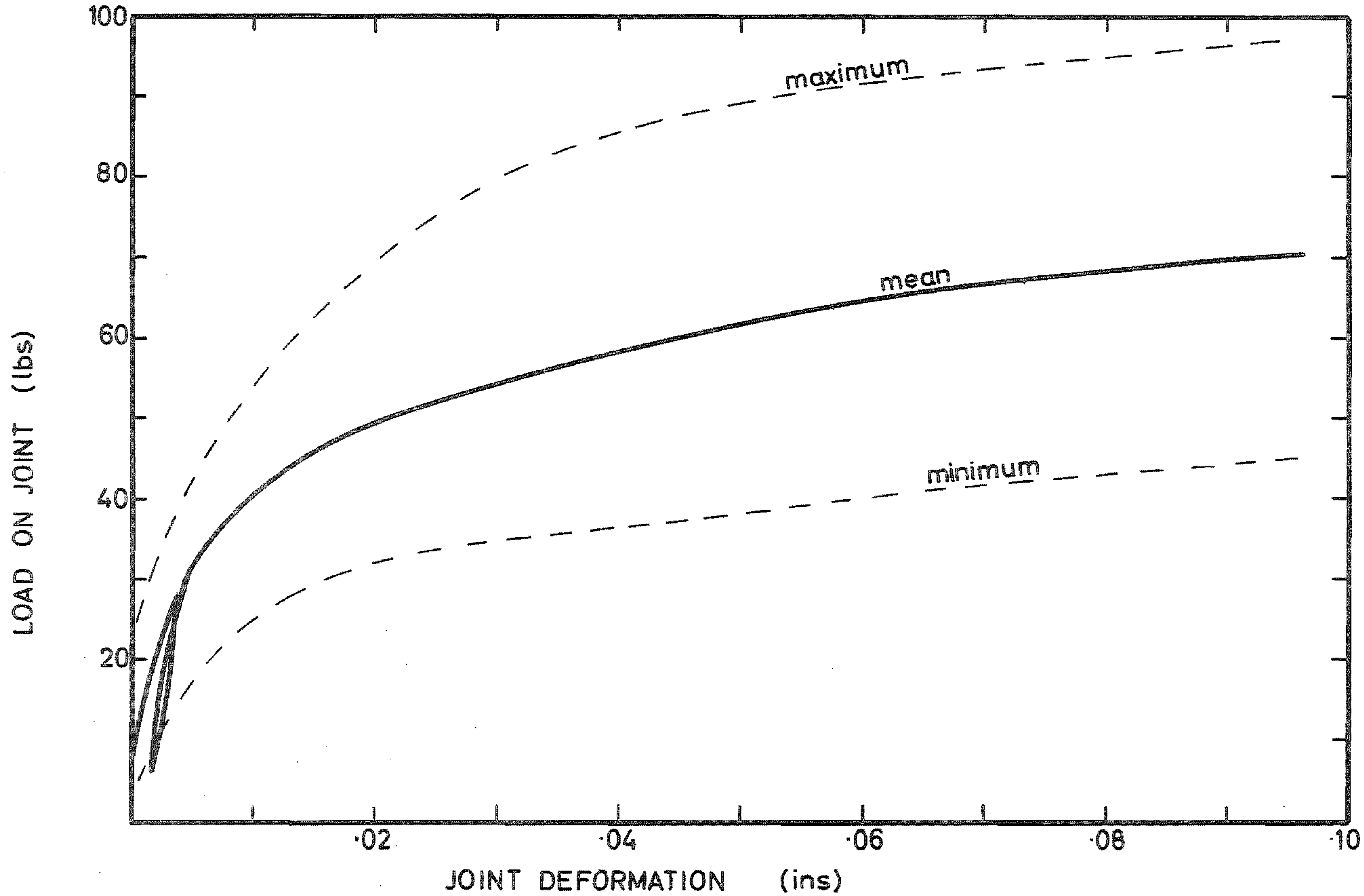


FIG. 4.12. Maximum, mean and minimum load-deformation curves for Series I model nailed joints. Load acting ⊥, //, and ⊥ to the grain of the three joint members respectively.

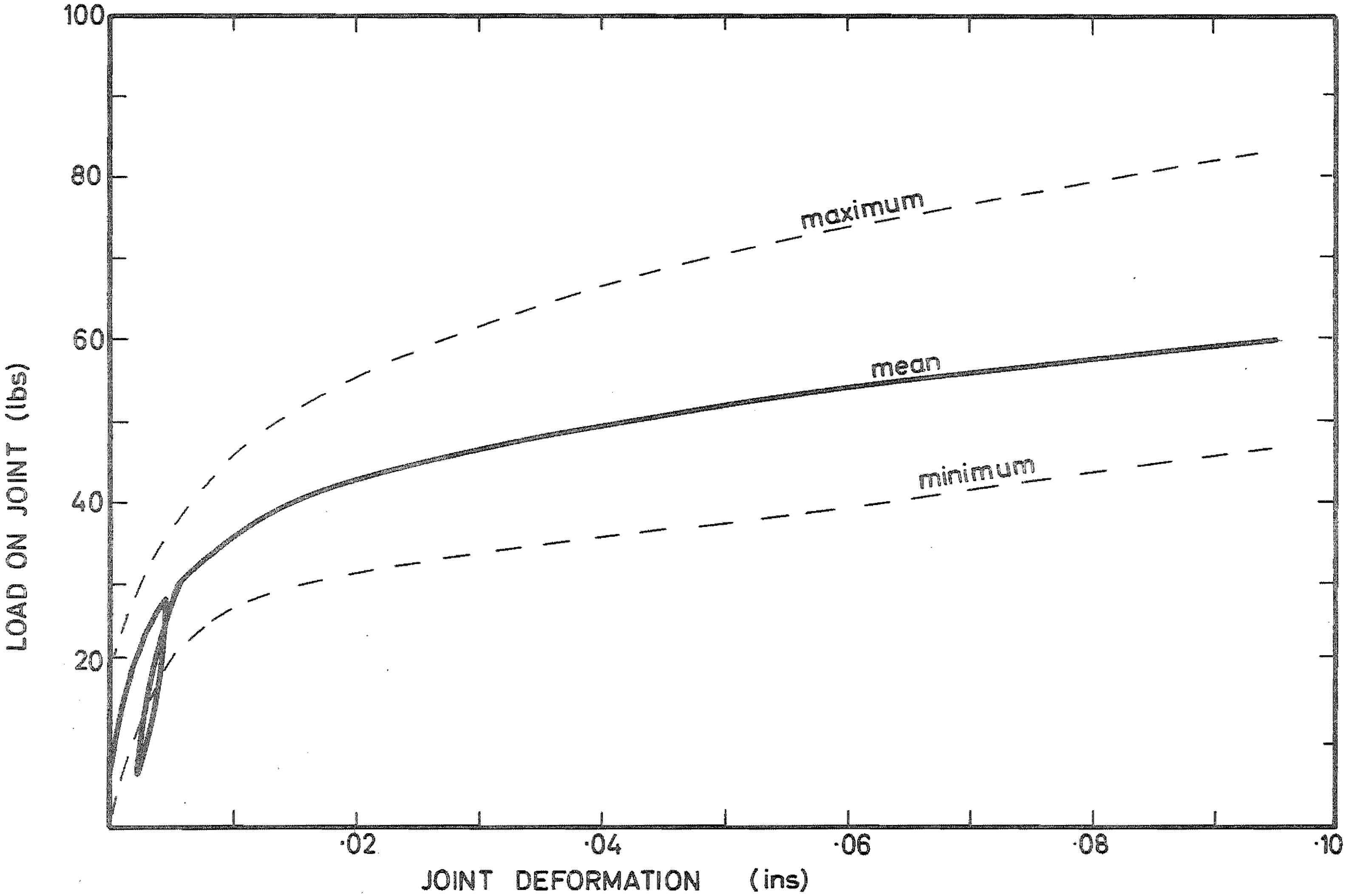


FIG.4.13. Maximum, mean and minimum load-deformation curves for Series II model nailed joints. Load acting //, ⊥ and // to the grain of the three members respectively.

4.4 ANALYSIS OF RESULTS OF PROTOTYPE AND MODEL JOINTS

4.4.1 Curve Fitting

For each joint the slip was calculated by subtracting algebraically the initial slip value from the values of deformation tabulated in tables A.1 and A.3.

To analyse the load-slip data it is necessary to consider the load cycle and the initial loading portions of the curves separately. This appears to be legitimate as the curves before and after the load cycle appear to be smoothly continuous. Also, Vermeyden[24] states: "a large number of tests have shown that the load-slip diagram is almost unaffected by the removal of load when the latter stays below 50-60% of the ultimate load."

An "elastic stiffness" value was calculated from the load cycle portion by equation [4.1]:

$$e = \frac{(P_1 - 2P_2 + P_3)}{(\delta_1 - 2\delta_2 + \delta_3)} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [4.1]$$

where e = elastic stiffness, and the subscripts 1, 2 and 3 refer to the beginning, minimum and end points respectively of the load cycle as shown in figure 4.11, and P and δ are the load and slip values at those points. This value of e should give an indication of the behaviour of the fastening under live loads.

To describe the behaviour on initial loading, expression [4.2], as derived by Mack[22] was fitted:

$$P = (A\delta + B)(1 - e^{C\delta})^D \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [4.2]$$

where e is the natural logarithm base and A, B, C and D are constants fitted by an iterative process to obtain a least squares best fit. In this curve fitting, the quantity being minimised was:

$$\sum_{1}^{n} \frac{(P - P_i)^2}{P_i}$$

where P is the value from expression [4.2] for each value of δ_i. This sum of squares was thus weighted to ensure a good fit for low values of P and δ. This was considered necessary in view of the theoretical relationship between the slip in a nailed joint and the shear strain in a nailed element which is derived in section 5.2.4. This relationship indicates that when a prototype nailed element reaches failure at a shear strain of about 6000 microstrain, the nailed joints in that element have undergone a slip of about .006 inch which corresponds to only 10% of their maximum load.

4.4.2 Relation to Grading Modulus

The values obtained for e, A, B, C and D are tabulated in table A.4 and are shown plotted against the respective values of grading modulus in figures 4.14 to 4.16, together with the regression lines and 90% confidence limits.

The statistics for the linear regressions between grading modulus and each of the coefficients e, A, B, C and D are listed in table 4.1.

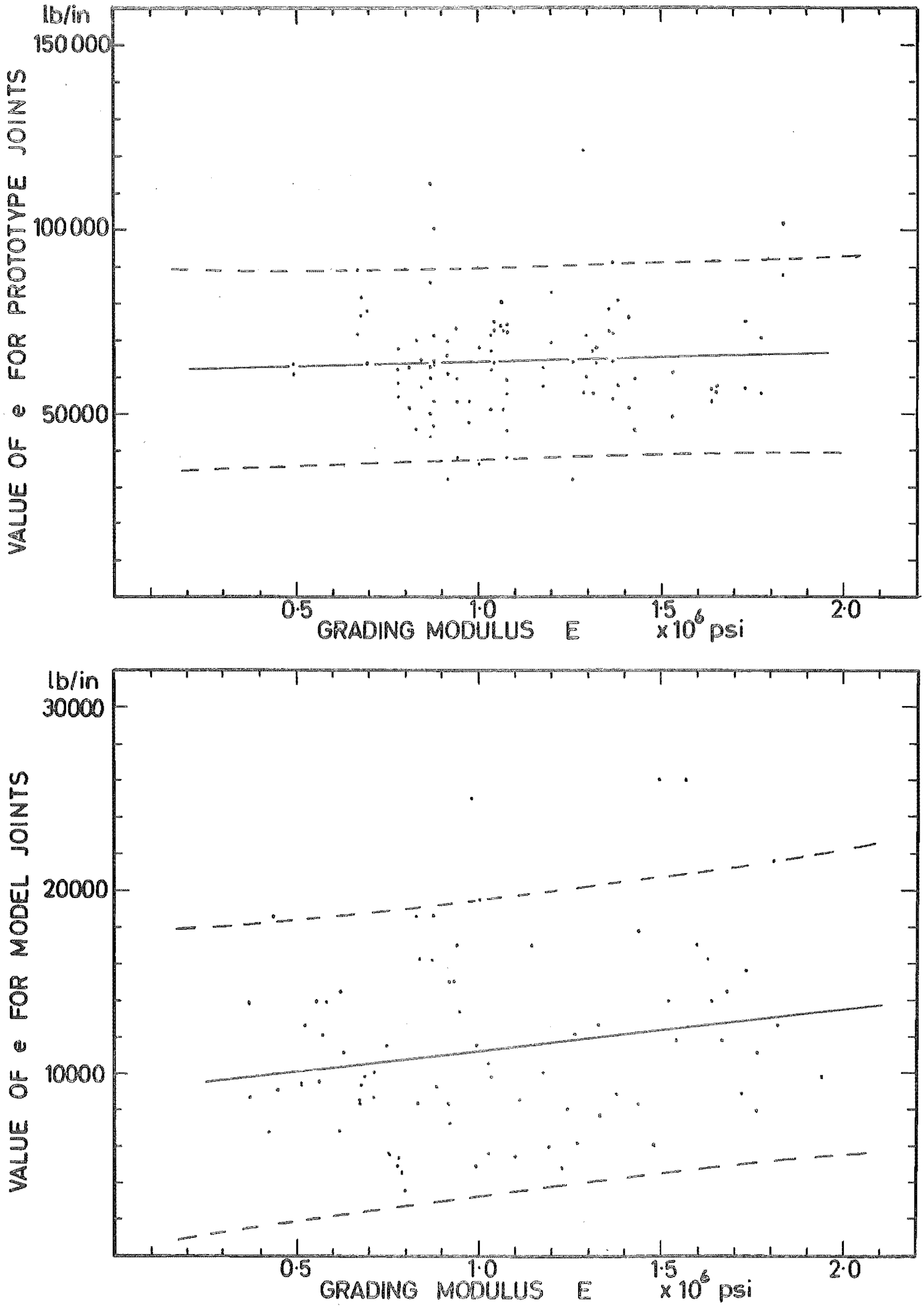


FIG. 4.14 Regression of "elastic stiffness" value e against grading modulus for both prototype and model nailed joints.

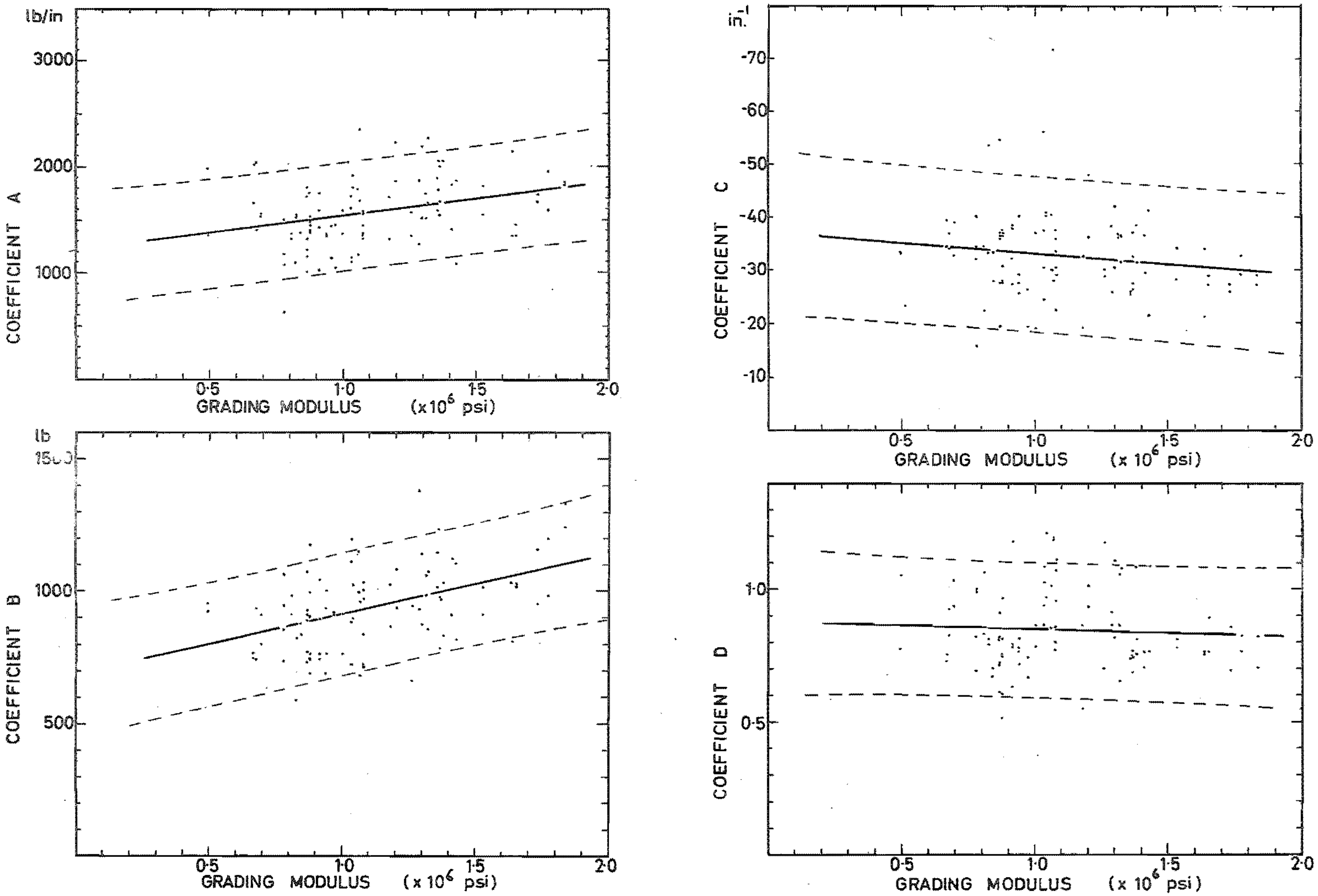


FIG. 4.15. Plot of coefficients A B C and D from the expression $P = (A\delta + B)(1 - e^{C\delta})^{D}$ fitted to the load-slip curves of the prototype nailed joints.

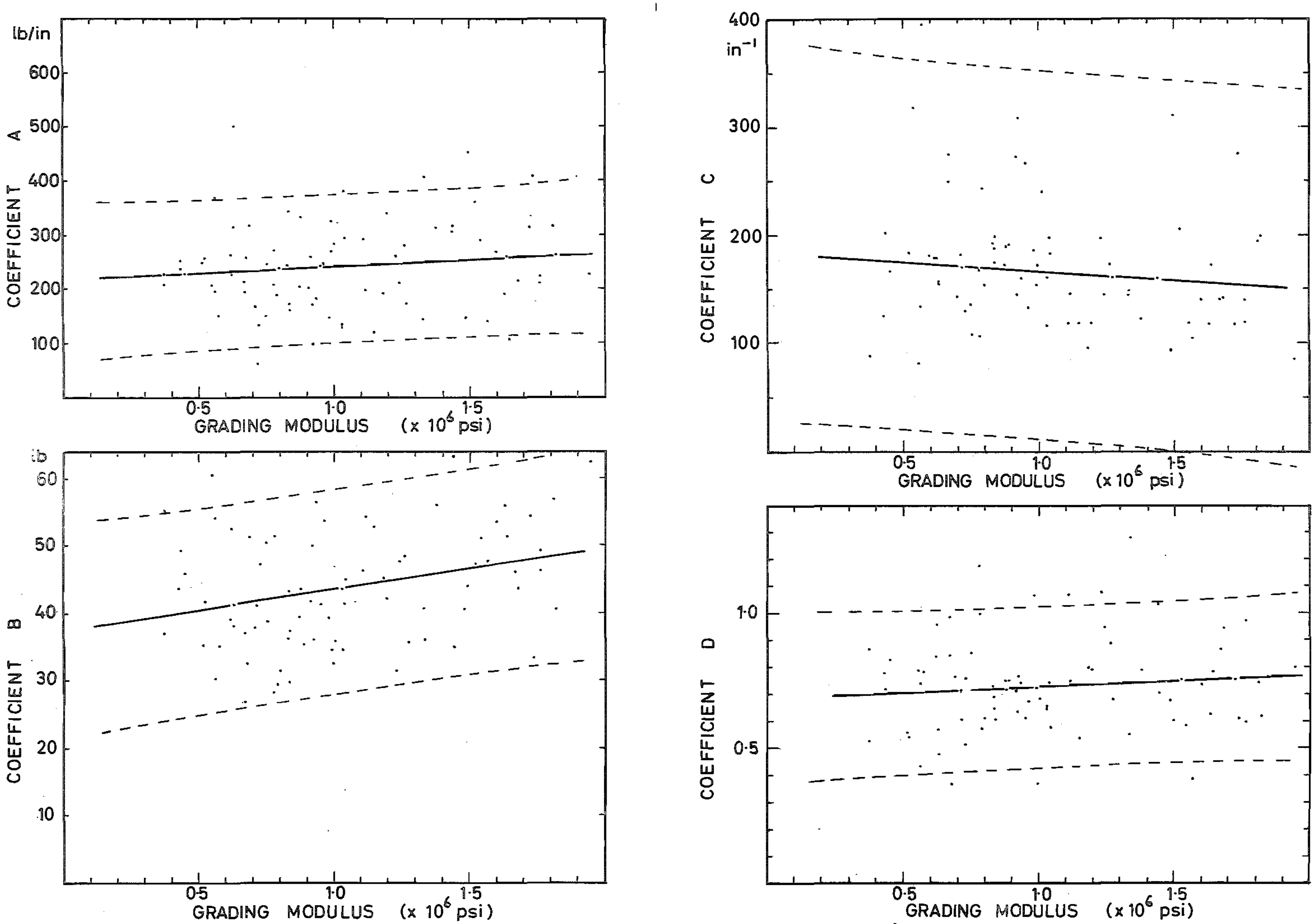


FIG. 4.16. Plot of coefficients A B C and D from the expression $P = (A\delta + B)(1-e^{C\delta})^{D}$ fitted to the load-slip curves of the model nailed joints.

TABLE 4.1 Statistical data for the regressions between grading modulus and the model and prototype nailed joint coefficients

STATISTIC	JOINT COEFFICIENT				
	e lb/in.	A lb/in.	B lb	C $in.^{-1}$	D
PROTOTYPE					
regression) $MX10^6$	2374	319.1	224.4	3.994	-.0306
coefficient) C	61584	1215.2	684.6	-37.417	.8819
correlation coeff. r	.048	.314*	.453**	.143	-.062
std dev. about regr. line	15530	304.4	139.0	8.728	.1548
value at E = $1.113X10^6$psi	64226	1570	934.4	-32.97	.8478
MODEL					
regression) $MX10^6$psi	741.6	24.78	5.809	22.46	.0413
coefficient) C	11861	214.24	37.546	-204.19	.6859
correlation coeff.	.040	.124	.258	.092	.095
value at E = $1.113X10^6$psi	13686	241.8	44.011	-179.2	.7319
scale factor	5	5	25	.2	1
scaled value	63428	1209	1100.3	-35.84	.7319

* significant correlation at 5% level

** " " " 1% "

The correlation coefficients were low, except for A and B for prototype joints, where significant correlations were found.

On examining the influence of the coefficients on the shape of the curve defined by [4.2], it is found that the term $(A\delta + B)$ defines a straight line fitted to the data above a slip of about 0.1 inch in the prototype joints or about 0.02 inch in the model joints. Coefficient C is found to define the point of maximum curvature of the load - slip curve, otherwise called yield of the joint, while coefficient D has a general smoothing effect. It may be expected then that coefficient D will have little or no correlation with E. Meyer[19] shows that the yield point of a nailed joint is dependent on the properties of the nail, the geometry of the joint and the crushing strength of the wood. Since, as found in section 3.2.2, crushing strength bears a significant correlation to grading modulus, coefficient C should be dependent upon E. Above the yield point the behaviour will depend upon the yield strength of the nail, the geometry of the joint, the crushing strength of the wood and the withdrawal resistance of the nail through the wood. The first two factors should be constant in this study, so A and B will be dependent upon the latter two factors and therefore also upon E.

4.4.3 Model-Prototype Comparison

The mean value of grading modulus for the prototype joints was 1.113×10^6 psi. If this value is substituted into the regression equations and the values for the model coefficients e, A, B, C and D are multiplied by scale factors of 5, 5, 25, 0.2 and 1 respectively, then comparable values are obtained as tabulated in table 4.1. These values show that very good similitude was obtained between the e values, the difference being only 0.05 times the prototype std. deviation. The values for A, B, C and D do not compare as well, however, with differences ranging from 1.2 to 0.33 times the respective prototype standard deviations. The curves given by these coefficients when they are substituted into equation [4.2] are shown in figure 4.17 together with the mean experimental data.

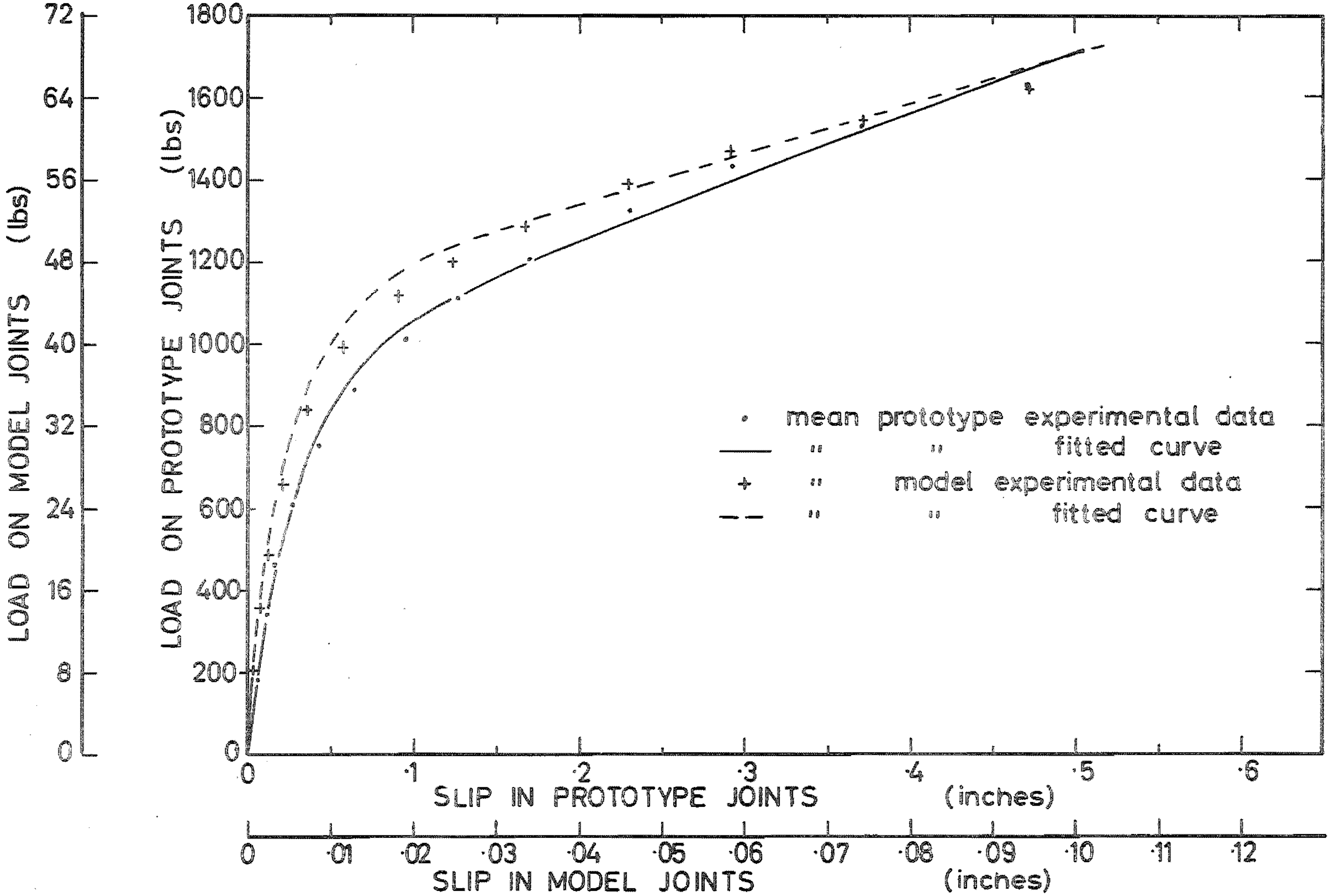


FIG. 4.17. Comparison of model and prototype fitted curves with mean experimental data.

These curves do not represent the best fit obtainable to the mean experimental data shown, but simply those given by the mean values of A, B, C and D. The maximum differences between experimental and fitted load values are 13.8% occurring at .0007 in. slip for the model data and 12.4% at .0056 in. slip for the prototype data. Fitting curves directly to the mean experimental data gave the values for A, B, C and D and the maximum differences tabulated in table 4.2.

TABLE 4.2 Coefficients obtained by fitting expression [4.2] to mean experimental data for model and prototype nailed joints

	MODULUS	VALUE OF COEFFICIENT				MAX. DIFF. BETW. EXP. & THEOR. LOADS	AT SLIP OF
	E	A	B	C	D		
	$X\ 10^6$ psi	lb/in.	lb	$in.^{-1}$		%	in.
Prototype	1.113	1551.1	939.1	-29.88	.8219	9.4	.0056
Model	1.042	240.4	43.42	-149.08	.7205	6.1	.0007

It appears from the foregoing discussion that the form of the equation [4.2] needs to be altered to obtain a better fit with the experimental data. This would probably involve introducing more coefficients and increase the difficulty of characterising the load - slip behaviour.

Mack[22] limited his curve-fitting to slips up to 0.1 inch in prototype joints whereas data up to 0.5 inch slip were fitted in this present study. If the curve fitting was limited to a low value of slip then it is possible that a closer fit would have been obtained but only up to the chosen limit.

When the mean data points plotted in figure 4.17 are considered, it appears that up to prototype slip values of 0.1 inch the model joints were from 15 to 25% stiffer than required for strict modelling at a linear scale of 1/5 while at a prototype slip of 0.5 inch the agreement is very close.

CHAPTER FIVE

PROTOTYPE SHELL ELEMENTS

Elements representative of a shell membrane with the three-layer, orthotropic construction described in section 1.3 were made and tested. Their stress-deformation behaviour in compression, shear, bending and torsion were observed. The effects of three nailing patterns, nail-gluing and a range of grading modulus from 0.5 to 1.9 X 10^6 psi were covered in this study, (ref. fig. 2.4).

5.1 LITERATURE SURVEY

The only work which appears to have been done on timber shell elements is contained in those works discussed previously. (Ref. section 1.2)

The work by Lee(2) included the testing of elements in shear, bending and torsion to determine the relative effects of fastening with plain wire nails, grooved shank nails, or grooved shank nails with casein glue. His shear test was based on the A.S.T.M. test for plywood(27), requiring elements as shown in figure 5.1. Hardwood blocks glued to the arms of the cruciform-shaped element carried axles and roller bearings so arranged that wedge-shaped loading heads applied loads parallel to the sides of the element. The elements were constructed of three layers of redwood T & G boards, $\frac{3}{8}$ X $2\frac{3}{4}$ in. with the layers mutually at right angles. Three elements, fastened with plain nails, grooved nails and nail-gluing were tested and failed at shear stresses of 313, 333 and 364 psi respectively. Shear moduli of 0.315, 0.185 and 1.15 X 10^4 psi respectively were calculated from the differences between the observed principal strains at a stress of 117 psi. This test method has been found(28) to give a substantially uniform strain

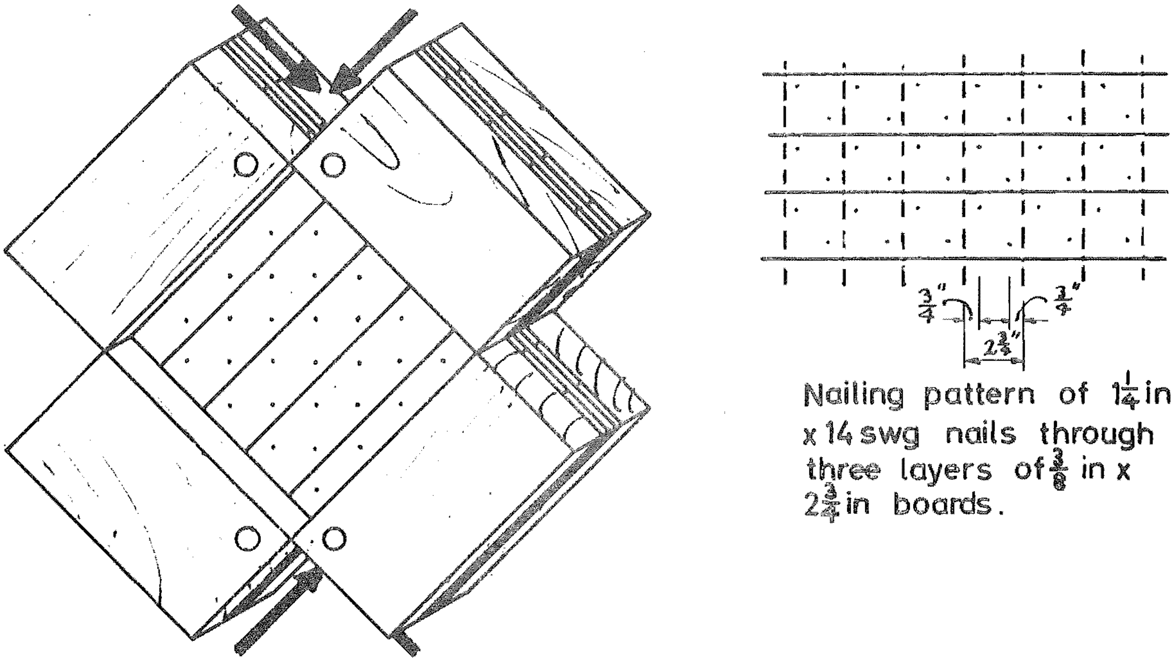


FIG.5.1. Shear element and nailing pattern used by Lee.

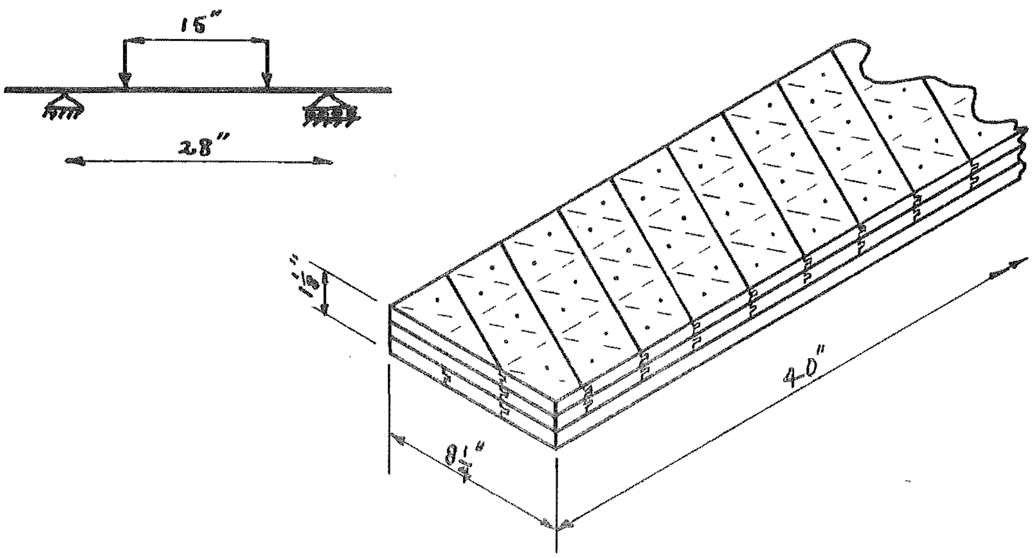


FIG.5.2. Element and loading arrangement for bending tests conducted by Lee.

distribution in solid wood elements as indicated by a brittle lacquer technique and so should be satisfactory for nail-glued elements. However, as the parallel to grain elastic modulus for redwood is about 1.2×10^6 psi, the shear modulus will be about 1/12 of this, viz. about 10×10^4 psi, which does not compare with the value of 1.15×10^4 psi, which Lee obtained. Furthermore, the shear stresses at failure for the three elements were very similar which means that the glued-on hardwood blocks must have reinforced the nailed elements since these should have a much lower strength than the nail-glued element. While this test method is satisfactory for solid wood and plywood elements, it appears unsuitable for shell elements.

The bending tests were conducted on elements measuring 40 in. by $8\frac{1}{4}$ in. by $1\frac{1}{8}$ in. of three layers of $\frac{3}{8} \times 2\frac{3}{4}$ in. T & G redwood boards arranged with one outer layer parallel to the length of the element and the other two at $\pm 60^\circ$ to this as in figure 5.2. Three elements, one for each type of fastening, were tested firstly with the boards parallel to the span in tension, and secondly in compression. An "effective" modulus of elasticity (E) was calculated from the observed radius of curvature (R) of the elements between the loading heads by the expression:

$E = \frac{M}{I} R$ where I is the moment of inertia assuming a homogeneous cross section. The values obtained are tabulated in table 5.1 and compared with a theoretical value to be expected from plywood of this construction according to the expression:

$E = 0.345E_o + 0.653E_{60}$ where E_o and E_{60} are the elastic moduli at 0° and 60° the grain respectively.

TABLE 5.1 Results of bending tests by Lee[2]

FASTENING OF LAYERS IN ELEMENT	STRESS IN LAYER OF BOARD PARALLEL TO SPAN	EFFECTIVE MODULUS IN BENDING (PSI)	
		OBSERVED	THEORETICAL
(a) $1\frac{1}{4}$"X14g plain wire nails	tension	0.087×10^6	0.528×10^6
	compression	0.067 " "	"
(b) $1\frac{1}{4}$"X14g grooved nails	tension	0.100 " "	"
	compression	0.086 " "	"
(c) as (b) plus casein glue	tension	0.258 " "	"
	compression	0.218 " "	"

Again the observed modulus of the nail-glued element is less than expected. This is possibly due to the discontinuous nature of each layer of boards.

The torsion tests by Lee[2] were based on a method used by March *et al.*[29] which consisted of loading a square element as shown in figure 5.3. Only isotropic or orthotropic materials may be tested thus as the elastic axes must be parallel to the plate edges. Elements measuring 66 X 66 X $2\frac{1}{4}$ in. were constructed in the same manner as the shear elements from $\frac{3}{4}$ in. by $5\frac{1}{2}$ in. T & G redwood boards. Two elements, employing 2 in. by 12 s.w.g. plain nails and 2 in. by 12 s.w.g. grooved nails with glue were tested. These gave shear modulus values of 4.23 and 5.60×10^4 psi which compares more closely with the expected value of about 10×10^4 psi.

Booth[4] tested two elements in bending, one nailed and the other nail-glued, to estimate the effect of including glue in the membrane of the

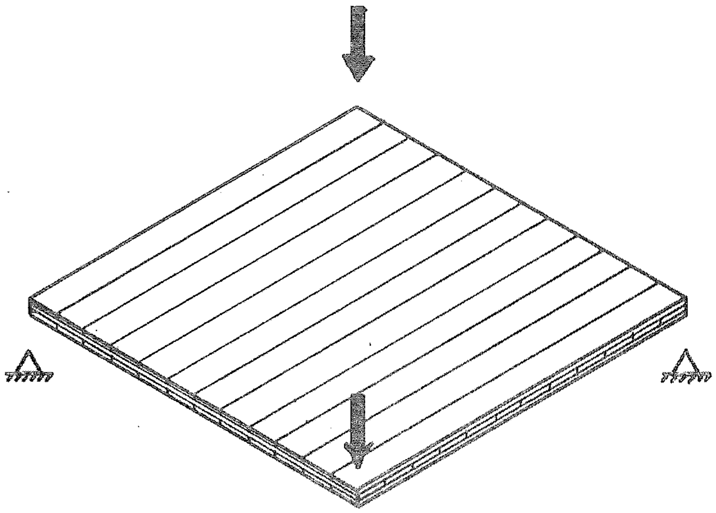


FIG. 5.3. Torsion test on square element conducted by Lee.

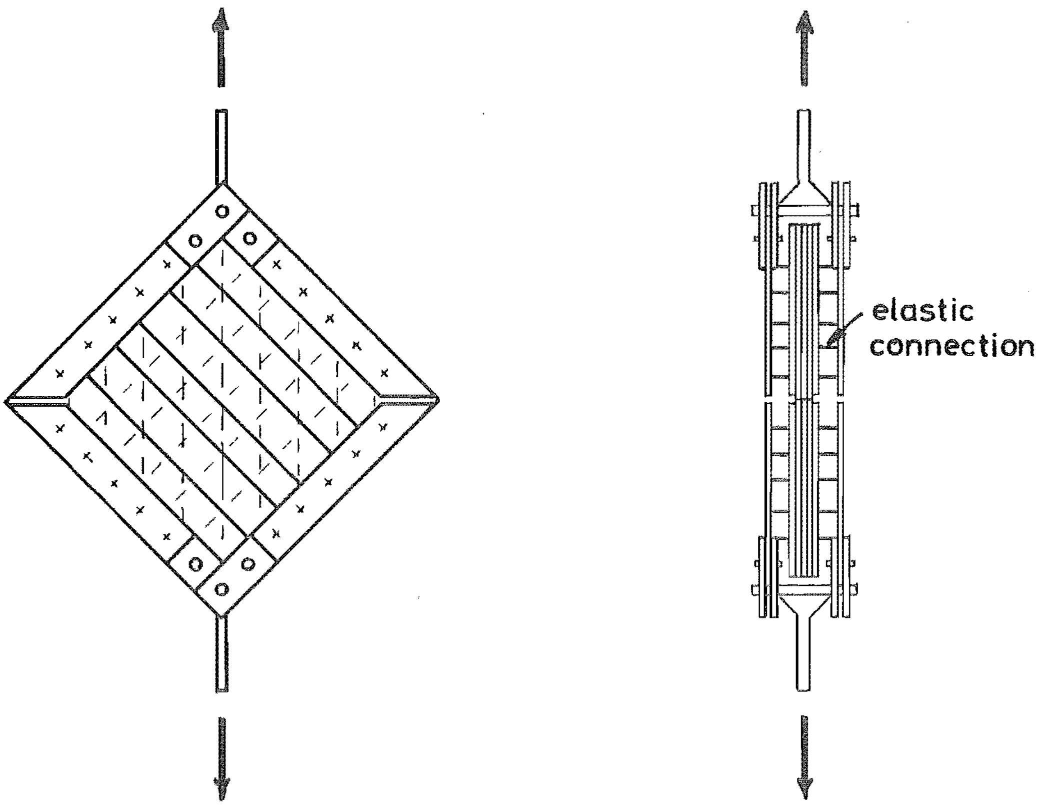


FIG. 5.4. Shear test on nail-glued element conducted by Pestman.

nailed conoid shell he had tested previously. These elements measured 7'X 4'X $1\frac{1}{8}$ in. and contained three layers of $\frac{3}{8}$ X $2\frac{1}{2}$ in. T & G redwood boards arranged with the middle and top layers at $\pm 30^{\circ}$ respectively to the bottom layer. The nail-glued element was found to be four times stiffer than the other under uniformly distributed load and simply supported at their ends. A 1:7.5 scale model glued element in balsa was tested by Barron(6) under similar conditions.

Pestman(3) reports only briefly on the testing of two nail-glued elements, one in shear and one in bending to determine design data for h.p. timber shells. These elements measured $31\frac{1}{2}$ in. square by $1\frac{5}{8}$ in. and were constructed of three layers of $2\frac{1}{2}$ in. wide boards arranged with two layers parallel to two adjacent sides of the element with the third layer parallel to a diagonal. A maximum shear stress of 1140 psi was obtained with the apparatus shown in figure 5.4. This value is of the same order as that usually obtained for plywood elements indicating that the apparatus probably did apply a substantially uniform shear stress.

5.2 THEORY

5.2.1 Definition of Terms

The internal forces and moments acting on the positive faces of an infinitesimal element of a shell membrane are defined with the positive directions as shown in figure 5.5 where:

T_1 and T_2 are the direct forces per unit length acting on surfaces normal to the axes X and Y respectively;

S is the shear force per unit length assumed to act equally on the surfaces normal to the axes X and Y and perpendicular to the direction of axis Z;

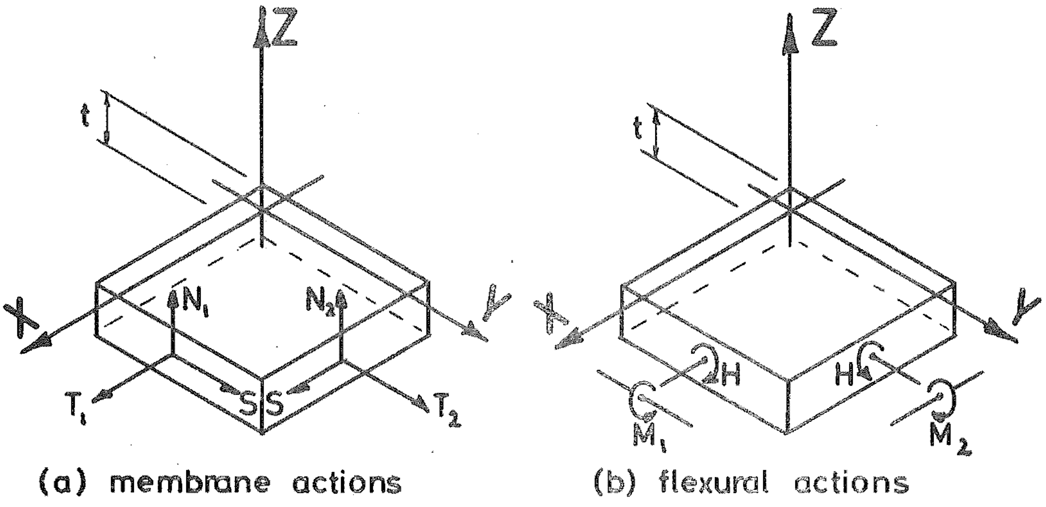


FIG.5.5. Definition of positive directions of membrane and flexural shell actions acting on an infinitesimally small element.

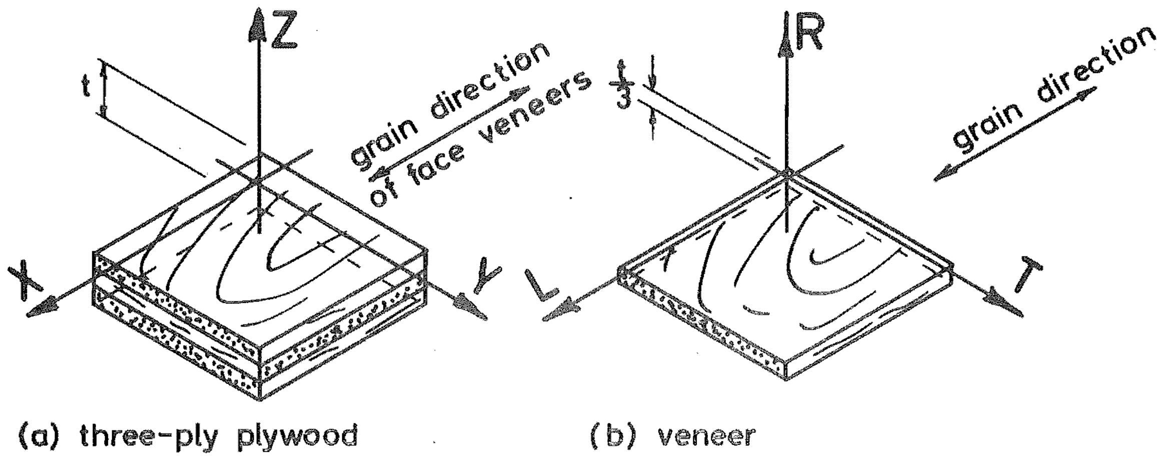


FIG.5.6. Definition of coordinate directions in an element of three-ply plywood and in one of its constituent veneers.

N_1 and N_2 are the shear forces per unit length acting on the surfaces normal to the axes X and Y respectively and in the direction of axis Z;

M_1 and M_2 are bending moments per unit length acting on the surfaces normal to axes X and Y respectively.

H is the torsional moment per unit length assumed to act equally on the surfaces normal to axes X and Y.

The orthogonal set of axes X, Y and Z may be curvilinear and the surface defined by z = 0 is assumed to lie at the mid-surface of the element.

The mid-surface strain-displacement relations of the element shown in figure 5.5 are defined by the expressions [5.1].

$$\varepsilon_x = \frac{\partial u}{\partial x}\ ;\ \varepsilon_y = \frac{\partial v}{\partial y}\ ;\ \gamma_{xy} = \frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}$$

$$k_x = \frac{\partial^2 w}{\partial x^2}\ ;\ k_y = \frac{\partial^2 w}{\partial y^2}\ ;\ k_{xy} = \frac{\partial^2 w}{\partial x \partial y} \qquad \ldots\ldots\ldots\ [5.1]$$

where: ε_x and ε_y are direct strains in direction X and Y respectively;

γ_{xy} is the shear strain in the surface z = 0;

k_x and k_y are curvatures in direction X and Y respectively;

k_{xy} is twist in the surface z = 0;

u, v and w are the displacements at the mid-surface of the infinitesimal element in the directions of axes X, Y and Z respectively.

5.2.2 Plywood Theory

It has been shown by Ambartsumyan(26) for a laminar shell of symmetrical construction that the strains may be related to the membrane actions T_1, T_2 and S by the expression [5.2]

$$\begin{bmatrix} \varepsilon_x \\ \varepsilon_y \\ \gamma_{xy} \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ S \end{bmatrix} \cdot \frac{1}{t} \quad \ldots\ldots\ldots\ldots \quad [5.2]$$

and the curvatures and twist to the flexural actions M_1 M_2 and H by the expression [5.3]

$$\begin{bmatrix} k_x \\ k_y \\ k_{xy} \end{bmatrix} = \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \begin{bmatrix} M_1 \\ M_2 \\ H \end{bmatrix} \cdot \frac{12}{t^3} \quad \ldots\ldots\ldots\ldots \quad [5.3]$$

where the terms A_{ij} and B_{ij} are coefficients relating the two sets of actions and curvatures.

Normal shear forces N_1 and N_2 may be ignored as the span to thickness ratio of shell membranes is normally large.

For a laminar shell of unsymmetrical construction however, the membrane and flexural actions and effects are not independent and a further eighteen coefficients are required to fully describe the relationship.

For an orthotropic shell membrane where the principal elastic axes coincide with the directions X and Y then expressions [5.2] and [5.3] reduce to [5.4] and [5.5] respectively.

$$\begin{bmatrix} \varepsilon_x \\ \varepsilon_y \\ \gamma_{xy} \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & \cdot \\ A_{21} & A_{22} & \cdot \\ \cdot & \cdot & A_{33} \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ S \end{bmatrix} \cdot \frac{1}{t} \quad \ldots\ldots\ldots\ldots \quad [5.4]$$

$$\begin{bmatrix} k_x \\ k_y \\ k_{xy} \end{bmatrix} = \begin{bmatrix} B_{11} & B_{12} & \cdot \\ B_{21} & B_{11} & \cdot \\ \cdot & & B_{33} \end{bmatrix} \begin{bmatrix} M_1 \\ M_2 \\ H \end{bmatrix} \cdot \frac{12}{t^3} \quad \ldots\ldots\ldots\ldots \quad [5.5]$$

In normal engineering terms, [5.4] and [5.5] are expressed as in [5.6] and [5.7] respectively.

$$\begin{bmatrix} \varepsilon_x \\ \varepsilon_y \\ \gamma_{xy} \end{bmatrix} = \begin{bmatrix} \frac{1}{E_x} & \frac{-\mu_{xy}}{E_y} & \\ \frac{-\mu_{yx}}{E_x} & \frac{1}{E_y} & \\ \cdot & \cdot & \frac{1}{G_{xy}} \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ S \end{bmatrix} \cdot \frac{1}{t} \quad \ldots\ldots\ldots\ldots \quad [5.6]$$

$$\begin{bmatrix} k_x \\ k_y \\ k_{xy} \end{bmatrix} = \begin{bmatrix} \frac{1}{D_x} & \frac{-\mu^1{}_{xy}}{D_y} & \cdot \\ \frac{-\mu^1{}_{yx}}{D_x} & \frac{1}{D_y} & \cdot \\ \cdot & \cdot & \frac{1}{D_{xy}} \end{bmatrix} \begin{bmatrix} M_1 \\ M_2 \\ H \end{bmatrix} \cdot \frac{12}{t^3} \quad \ldots\ldots\ldots\ldots \quad [5.7]$$

where: E_x and E_y are Young's moduli in directions X and Y respectively; μ_{xy} and μ_{yx} are Poisson ratios where the second subscript defines the direction of the action and the first subscript defines the direction of the strain.

G_{xy} is the shear modulus for the plane z = 0;

D_x and D_y are flexure moduli in directions X and Y respectively;

$\mu^1{}_{xy}$ and $\mu^1{}_{yx}$ are Poisson ratios for flexure where the second subscript defines the direction of the bending action and the first subscript defines the direction of the curvature;

D_{xy} is the torsion modulus for the plane $z = 0$.

Consider now an element of plywood as shown in figure 5.6(a) which is constructed of three veneers of equal thickness arranged orthotropically. Let the Longitudinal (L), Tangential (T), and Radial (R) directions of the individual veneers be defined as in figure 5.6(b) and their elastic properties by expression [5.8]:

$$\begin{bmatrix} \varepsilon_L \\ \varepsilon_T \\ \gamma_{LT} \end{bmatrix} = \begin{bmatrix} \frac{1}{E_L} & -\frac{\mu_{LT}}{} & \cdot \\ \frac{-\mu_{TL}}{E_L} & \frac{1}{E_T} & \cdot \\ \cdot & \cdot & \frac{1}{G_{LT}} \end{bmatrix} \begin{bmatrix} \sigma_L \\ \sigma_T \\ \tau_{LT} \end{bmatrix} \quad \ldots\ldots\ldots\ldots\ldots \quad [5.8]$$

where: ε_L, ε_T and γ_{LT} are the direct and shear strains;

σ_L, σ_T and τ_{LT} are the direct shear stresses;

E_L, E_T, μ_{TL}, G_{LT} are the normal engineering constants associated with axes L, T and R.

Tottenham[5] gives the following relationships between the coefficients of expressions [5.6], [5.7] and [5.8]:

$$E_x = E_L \cdot \frac{(1 - \mu_{xy} \cdot \mu_{yx})}{(1 - \mu_{LT} \cdot \mu_{TL})} \cdot \frac{(2 + \lambda)}{3} ;$$

$$E_y = E_L \cdot \frac{(1 - \mu_{xy} \cdot \mu_{yx})}{(1 - \mu_{LT} \cdot \mu_{TL})} \cdot \frac{(1 + 2\lambda)}{3} ;$$

$$\mu_{xy} = \frac{3}{2 + \lambda} \cdot u_{LT} ; \quad \mu_{yx} = \frac{3}{1 + 2\lambda} \cdot u_{LT}$$

$$\lambda = \frac{E_T}{E_L} ; \quad G_{xy} = G_{LT} ;$$

$$D_x = E_L \frac{(1 - \mu^1{}_{xy} \cdot \mu^1{}_{yx})}{(1 - \mu_{LT} \cdot \mu_{TL})} \cdot \frac{(26 + \lambda)}{27} \quad \ldots\ldots\ldots\ldots \quad [5.9]$$

$$D_y = E_L \cdot \frac{(1 - \mu^1{}_{xy} \cdot \mu^1{}_{yx})}{(1 - \mu_{LT} \cdot \mu_{TL})} \cdot \frac{(1 + 26\lambda)}{27} ;$$

$$\mu^1{}_{xy} = \frac{27}{26 + \lambda} \cdot \mu_{LT} ; \quad \mu^1{}_{yx} = \frac{27}{1 + 26\lambda} \cdot \mu_{LT}$$

$$D_{xy} = G_{LT}$$

Expressions [5.9] are derived on the assumptions that:

(a) The veneers are homogeneous, linearly elastic and are not stressed beyond their elastic limit;

(b) The glue lines are vanishingly thin;

(c) No slip occurs at the gluelines;

(d) Straight lines normal to the plane of the plywood remain normal and straight after the plywood is stressed.

5.2.3 Nail-Glued Elements

The nail-glued elements studied in this work compare closely with threeply plywood except for two features. Firstly, the layers of the elements are discontinuous since they are composed of discrete boards while in plywood the veneers are continuous except for lathe checks.

Secondly, the Radial and Tangential directions occur in rotary cut veneer as shown in figure 5.6(b) while in the boards of an element they will be randomly oriented. If these differences are not significant then the theory given in the previous section will apply to nail-glued elements where the grain directions of the veneers are the board directions in the elements.

To estimate values E_L, E_T, u_{LT}, u_{TL} and G_{LT}, a mean value of MOE in static bending of 0.988×10^6 psi is obtained from section 3.2.3 for the radiata pine used in this study. From data by Stewart and Kloot[15] for radiata pine, the modulus of elasticity in compression parallel to the grain (E) will be about 1.115 times the MOE in static bending. Hence a value of 1.10×10^6 psi for E_L may be expected for the radiata used in this study. From the same data an expected value G_{LT} of 9.1×10^4 psi is similarly obtained. Hearmon[30] presents elastic constants for six structural softwoods from which a mean value of the ratio $E_T:E_L$ of 0.0576:1 is found. Assuming that this mean value applies to radiata, a value of E_T of 6.34×10^4 psi may be expected. From Hearmon's data values of u_{LT} and u_{TL} of 0.024 and 0.446 respectively are also obtained.

Substituting the above values into equations [5.9] yields values for expressions [5.6], [5.7] and [5.8].

$$\begin{bmatrix} \frac{1}{E_L} & \frac{-\mu_{LT}}{E_T} & . \\ \frac{-\mu_{TL}}{E_L} & \frac{1}{E_T} & . \\ . & . & \frac{1}{G_{LT}} \end{bmatrix} = \begin{bmatrix} .910 & -.378 & . \\ -.405 & 15.8 & . \\ . & . & 11.1 \end{bmatrix} \text{X } 10^{-6} \text{in.}^2/\text{lb} \;.\;. \quad [5.8]\text{a}$$

$$\begin{bmatrix} \frac{1}{E_x} & \frac{-\mu_{xy}}{E_y} & . \\ \frac{-\mu_{yx}}{E_x} & \frac{1}{E_y} & . \\ . & . & \frac{1}{G_{xy}} \end{bmatrix} = \begin{bmatrix} 1.314 & -.0919 & . \\ -.0918 & 2.424 & . \\ & & 11.1 \end{bmatrix} \text{X } 10^{-6} \text{in.}^2/\text{lb} \;.\;. \quad [5.6]\text{a}$$

$$\begin{bmatrix} \frac{1}{D_x} & \frac{-\mu^1_{xy}}{D_y} & . \\ \frac{-\mu^1_{yx}}{D_x} & \frac{1}{D_y} & . \\ . & . & \frac{1}{D_{xy}} \end{bmatrix} = \begin{bmatrix} .938 & -2.264 & . \\ -.264 & 9.788 & . \\ . & . & 11.1 \end{bmatrix} \text{X } 10^{-6} \text{in.}^2/\text{lb} \;.\;. \quad [5.7]\text{a}$$

These values are those expected for nail-glued elements at a mean grading modulus of $1.077 \text{ X } 10^6$ psi at 10.7% moisture content.

5.2.4 Nailed Elements

In the nailed elements, slip must occur between the layers if the nails are to transfer load. For an element under action T_1 or T_2, (i.e. load parallel or perpendicular to the direction of the outer layers of boards), if it is assumed that the relative movement between the layers due to the Poisson ratio effect is too small for the nails to transfer significant load, then each layer may be considered to act unrestrained by the others. On this assumption Hearmon shows that terms A_{11} and A_{22} in [5.4] are given by:

$$A_{11} = \frac{1}{E_L} \cdot \frac{3}{2 +} = 1.33 \times 10^{-6} \text{ in.}^2/\text{lb},$$

$$A_{22} = \frac{1}{E_L} \cdot \frac{3}{1 + 2} = 2.45 \times 10^{-6} \text{ in.}^2/\text{lb}$$

As the layers are assumed to act independently for a given imposed strain ε_x, the resultant Poisson ratio strains ε_y will be different for the outer and middle layers. Since the strains in these elements are to be measured on the surface, A_{12} and A_{21} will apply to the outer layers, i.e. those whose boards lie in direction X. Thus A_{12} and A_{21} are given by:

$$A_{12} = -\mu_{LT} \cdot A_{22} = -0.0636 \times 10^{-6} \text{ in.}^2/\text{lb}$$

$$A_{21} = -\mu_{TL} \cdot A_{11} = -0.591 \times 10^{-6} \text{ in.}^2/\text{lb}$$

No theoretical work appears to have been done on nailed shell elements in shear. The following derivation of a relationship between action S and strain γ_{xy} is therefore proposed:

Consider a square element of side length a, as shown in figure 5.7 in an exaggerated deformed shape. The nailed elements tested by the author were observed to assume this deformed shape with slip occurring between adjacent boards in each layer. Assume that the layers are fastened according to nailing pattern 3 as shown in figure 1.1 and consider action S as two equal and complementary actions S_{xy} and S_{yx} as shown in figure 5.7.

If the actions S_{xy} and S_{yx} have caused the element to undergo

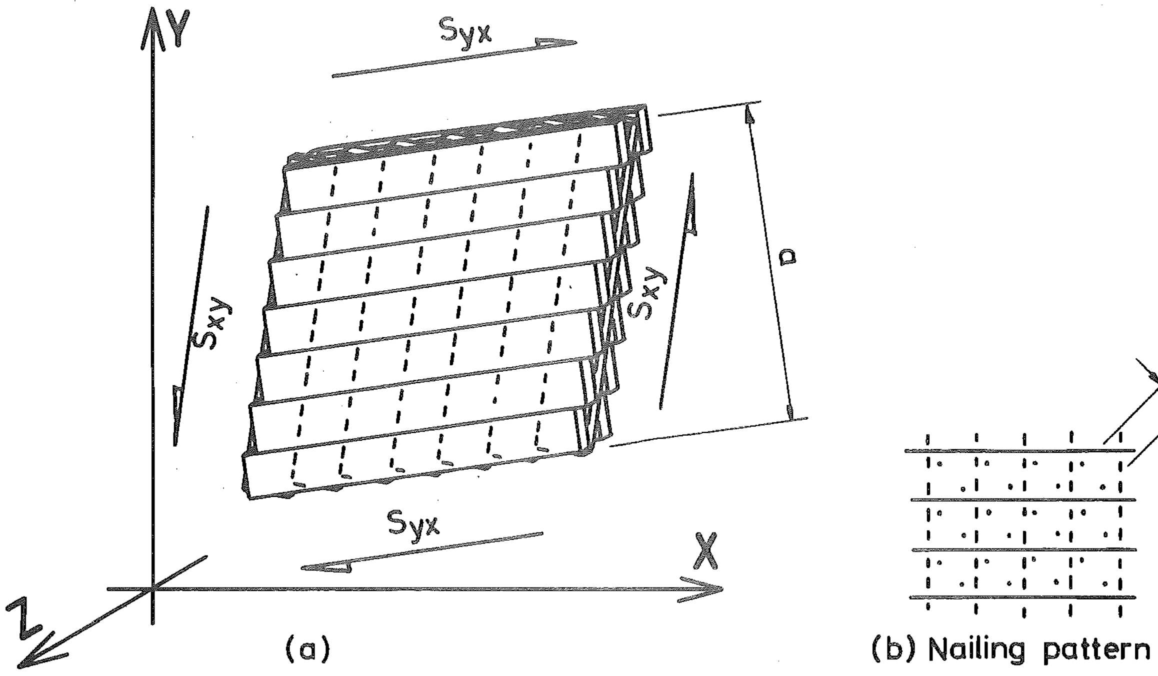


FIG.5.7. Nailed element deformed under shear action.

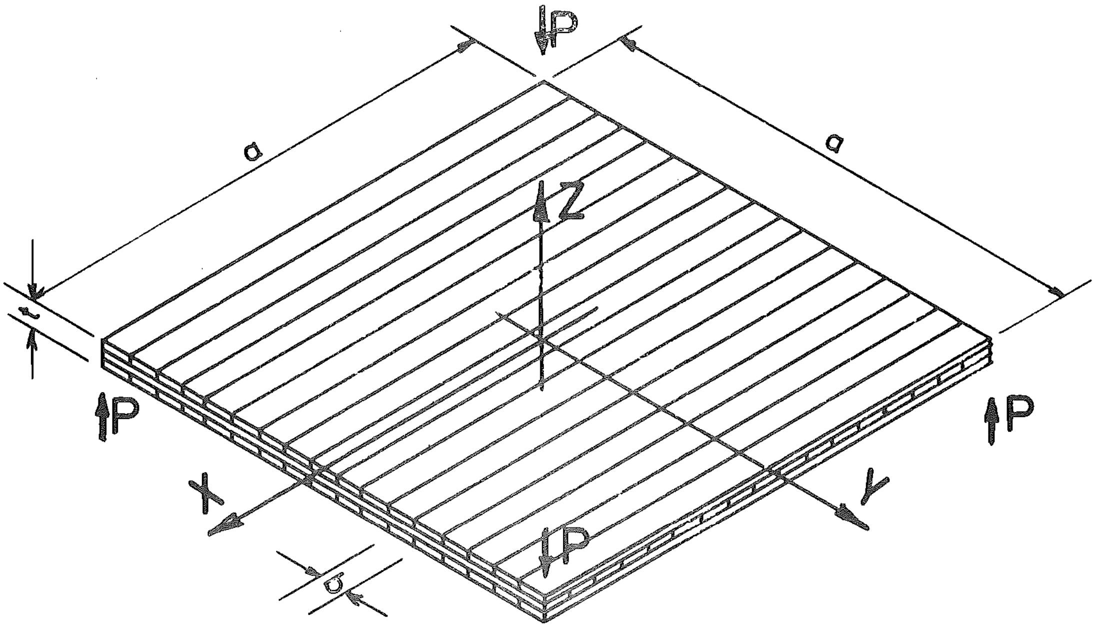


FIG.5.8. Loads P acting at the corners of a square element to produce torsional action H

shear strain γ_{xy} then the relative rotation between the boards of the middle and outer layers will be equal to γ_{xy}. Let d, be the distance between the pair of nails at each board crossing as shown in figure 5.7(b). The relative slip (δ) between the layers at each nail will therefore be given in [5.10].

$$\delta = \gamma_{xy} \cdot \frac{d}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [5.10]$$

Let the load transferred between the middle and the outer layers by each nail be given by $P(\delta)$ where P is a function of δ. Therefore the moment (M) on each nail pair will be given by [5.11].

$$M = P(\delta) \cdot d \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [5.11]$$

If the number of nails per unit area is n, then the number of nail pairs over the whole element will be $\frac{na^2}{2}$. Therefore the total moment transferred between the middle and outer layers will be:

$$M. \frac{n.a^2}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [5.12]$$

Assume that S_{xy} acts only on the middle layer while S_{yx} acts only on the outer layers. Thus the moment transferred from the middle to the outer layers is given by [5.13].

$$S_{xy}.\ a.a = S_{yx}.\ a.a = S.a.a \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [5.13]$$

Equating [5.12] and [5.13] gives [5.14].

$$S.a^2 = P(\gamma_{xy}.\ \frac{d}{2}).\ d.\ n.\frac{a^2}{2}$$

$$\text{i.e.}\quad S = P(\gamma_{xy}\ \frac{d}{2}).\ \frac{dn}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [5.14]$$

From table 4.1, the value of $P(\delta)$ for prototype joints at $E = 1.077 \times 10^6$ psi is found to be: $P = (1536\delta + 911)(1 - e^{-33.4\delta})^{0.8511}$ lb for initial loading and $P = e\,\delta = 63975\delta$ lb for load cycling.

For prototype nailed elements with nailing pattern 3,

$d = \frac{3.5}{2} \sqrt{2} = 1.35$ in. and $n = 23.2$ nails/sq ft $= 0.161$ nails/sq in.

Substituting these values into equation [5.14] we obtain:

$$S = \frac{1.35 \times 0.161}{2} (1536 \times 0.675\gamma_{xy} + 911)(1-e^{-33.4 \times 0.675\gamma_{xy}})^{0.8511} \text{ lb/in.} \quad \ldots \quad [5.15]$$

for initial loading and

$$S = \frac{1.35 \times 0.161}{2} \times 63975 \times 0.675\gamma_{xy} \text{ lb/in.} \quad \ldots\ldots\ldots \quad [5.15]$$

for loading cycling.

Since [5.15] is a curvilinear relationship, A_{33} may be determined from [5.16] only as:

$$A_{33} = \frac{t}{S}\gamma_{xy} = 533 \times 10^{-6} \text{ in.}^2/\text{lb}$$

The values of A_{33} for elements with nailing patterns 1 and 2 will be 4 and 2 times these values respectively since they contain respectively $\frac{1}{4}$ and $\frac{1}{2}$ the nailing density.

Thus for nailed prototype elements with nailing pattern 2 the constants A_{ij} in expression [5.6] become:

$$\begin{bmatrix} \frac{1}{E_x} & \frac{-\mu_{xy}}{E_y} & \cdot \\ \frac{-\mu_{yx}}{E_x} & \frac{1}{E_y} & \cdot \\ & & \frac{1}{G_{xy}} \end{bmatrix} = \begin{bmatrix} 1.33 & -.0636 & \cdot \\ -.591 & 2.45 & \cdot \\ \cdot & \cdot & 1065 \end{bmatrix} \times 10^{-6} \text{in.}^2/\text{lb} \quad \ldots \quad [5.6]$$

Considering now the flexural behaviour of nailed elements, it is again assumed that the relative movements between the layers due to Poisson ratio effects are too small for the nails to transfer significant load. Hence substituting $\mu_{LT} = \mu_{TL} = 0$ in expression [5.9] it is found that:

$$B_{11} = \frac{1}{D_x} = \frac{1}{E_L} \cdot \frac{27}{26 + \lambda} = 0.942 \times 10^{-6} \text{ in.}^2/\text{lb}$$

$$B_{22} = \frac{1}{D_y} = \frac{1}{E_L} \cdot \frac{27}{1 + 26\lambda} = 9.828 \times 10^{-6} \text{ in.}^2/\text{lb}$$

$$B_{12} = B_{21} = 0$$

No theoretical work appears to have been done on nailed elements under action H. The following derivation of a value for B_{33} is therefore proposed:

Consider a square nailed element of side a, as shown in figure 5.8. Action H is produced by loads P acting normal to the plane at each corner. In a homogeneous material action H produces shear stress in the plane XY. However, in a laminar, boarded element this state of stress cannot exist as the shear stresses cannot be transmitted directly from board to board in each layer except by friction which is an uncertain quantity. Therefore some other state of stress must exist and here it is assumed that each board is stressed in torsion as a separate unit.

Let the dimensions of the element be a X a X t and the width of an individual board be b.

The action H is related to the loads P by the expression:

$$H = \frac{1}{a} \cdot \frac{P}{2} \cdot a = \frac{P}{2} \text{ lb-in./in.}$$

The torsional moment on the whole element is equal to Pa lb-in. Therefore if each layer carries the same moment, the moment on each layer will be $\frac{Pa}{3}$ lb-in. As the number of boards in each layer is given by $\frac{a}{b}$, the torsional moment (M) on each board will be given by:

$$M = \frac{b}{a} \cdot \frac{Pa}{3} = \frac{Pb}{3} \text{ lb-in.}$$

Assuming that the twist in each board is equal to the twist k_{xy} of the whole element, then the moment M is related to twist k_{xy} by the expression

$$M = J\, G_{xy}\, k_{xy}$$

where G_{xy} is the modulus of rigidity in torsion and J is the polar moment of inertia of the cross section of each board.

Therefore:

$$k_{xy} = \frac{M}{JG_{xy}} = \frac{Pb}{3JG_{xy}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [5.17]$$

From expressions [5.5] and [5.7] we have:

$$B_{33} = \frac{1}{D_{xy}} = \frac{k_{xy}}{H} \cdot \frac{t^3}{12} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [5.18]$$

and substituting from [5.17], we have:

$$B_{33} = \frac{2b}{3JG_{xy}} \cdot \frac{t^3}{12} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [5.19]$$

Hearmon(30) shows that for a rectangular bar of orthotropic material, (such as wood), under torsion:

$$J = \beta d^3 b$$

where, in this study:

b = board width = 3.5 in. and

d = board thickness = 0.85 in. and

β = 0.272 for a ratio of d/b of 0.243

Substituting in [5.19] for $G_{xy} = G_{LT} = 9.01 \times 10^4$ psi and t = 2.5 in. we have:

$$B_{33} = 57.68 \times 10^{-6} \text{ in.}^2/\text{lb for a nailed element in torsion.}$$

Thus for nailed elements the constants B_{ij} in expression [5.7] become:

$$\begin{bmatrix} \frac{1}{D_x} & \frac{\mu^1_{xy}}{D_y} & . \\ \frac{\mu^1_{yx}}{} & \frac{1}{D_y} & . \\ . & . & \frac{1}{D_{xy}} \end{bmatrix} = \begin{bmatrix} 0.942 & . & . \\ . & 9.828 & . \\ . & . & 57.68 \end{bmatrix} \times 10^{-6} \text{in.}^2/\text{lb} \qquad [5.7]\text{b}$$

when the mean grading modulus in that element is 1.077×10^6 psi at 10.7% moisture content.

5.3 EXPERIMENTAL INVESTIGATION

5.3.1 Element Preparation

The loading systems used to subject elements to the shell actions defined in figure 5.5 are shown schematically in figures 5.8 and 5.9.

The details of each element are given in table B.1 in the appendix.

From the stacked prototype boards, lengths were selected for each element, cut out and conditioned at 57 ±2% r.h. and 68 ±2°F for two to four weeks before assembly. For assembly of the flexure elements, a 5 X 8 ft flat table was constructed of 13/16 in. thick coreboard panels. These were nailed to 6 X 2 in. timber joists at 2 ft centres and clamped to a steel frame which was set on concrete blocks. A 9 in. wide piece of coreboard screwed to this table at one end formed a stop against which the bottom layer of boards were cramped and then held by a similar stop clamped to the table. This assembly jig is shown in figure 5.10. The cramps were made from hydraulic rams fixed to a frame and acting on a distribution beam. These could be operated independently as in figure 5.11 or together to apply a cramping force of 20 lb/in. to a layer of boards.

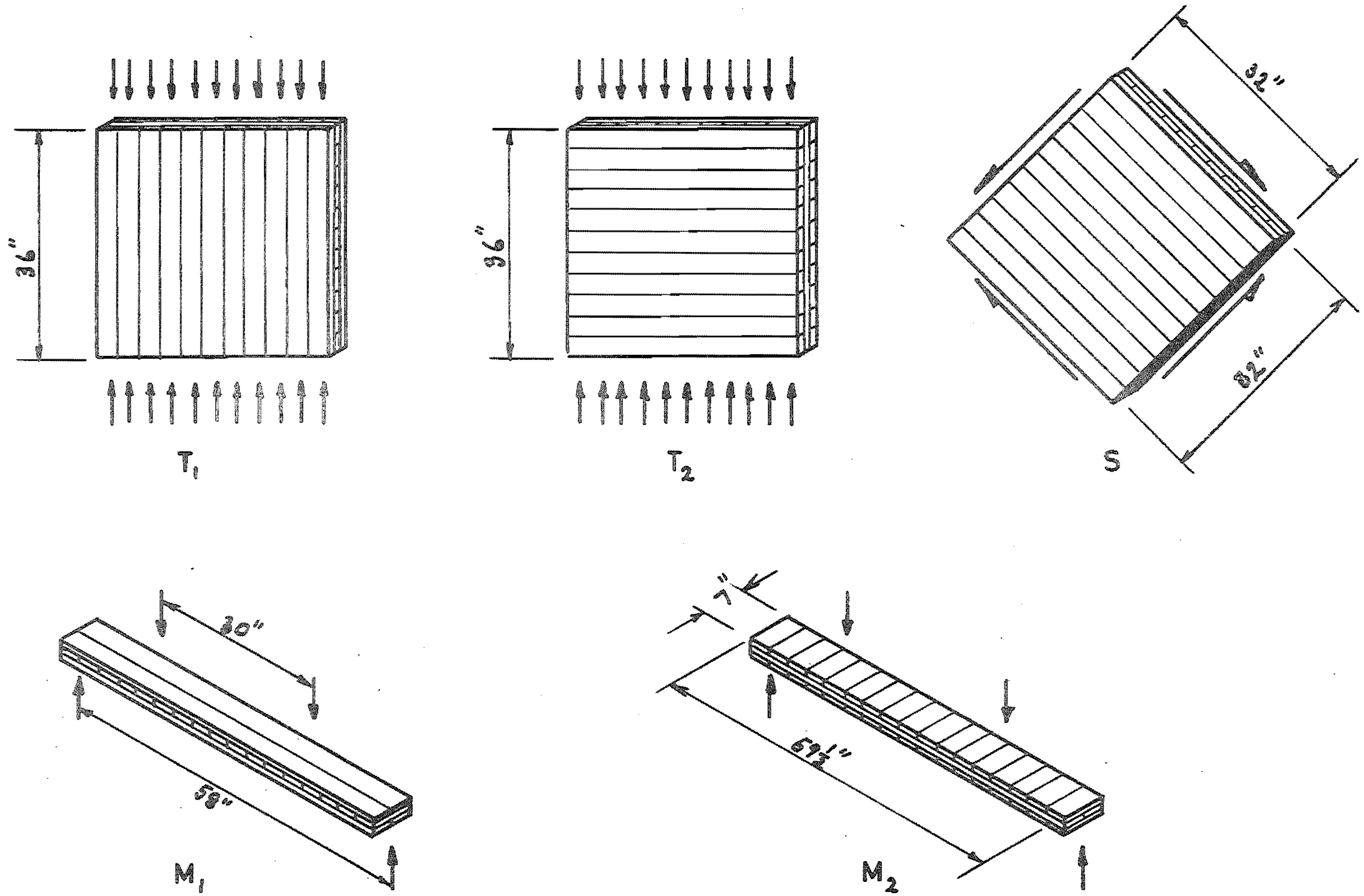


FIG.5.9. Schematic diagram of the loading systems used to produce shell actions T_1, T_2, S, M_1, M_2, on prototype and model elements.

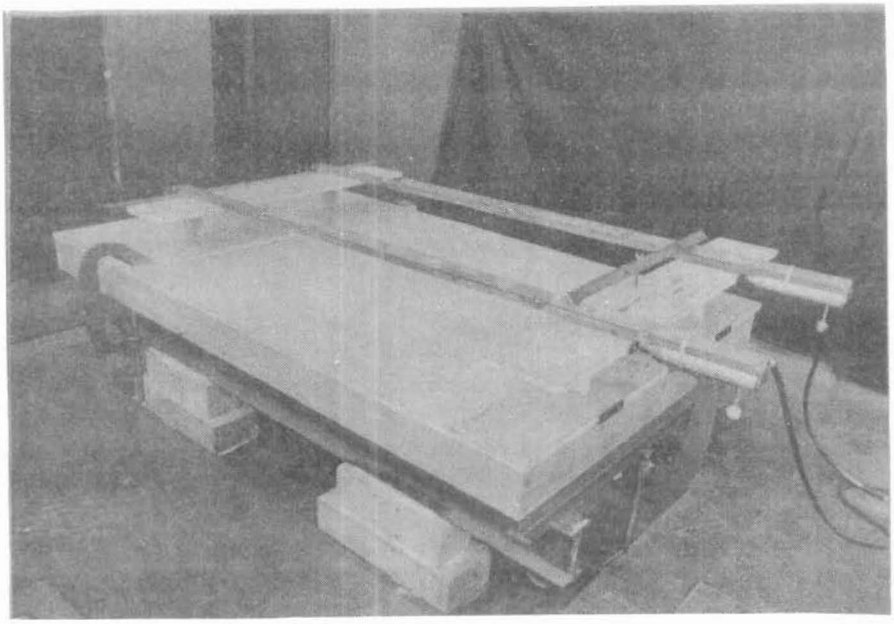


FIG.5.10 Assembly jig and cramps for prototype flexure elements.

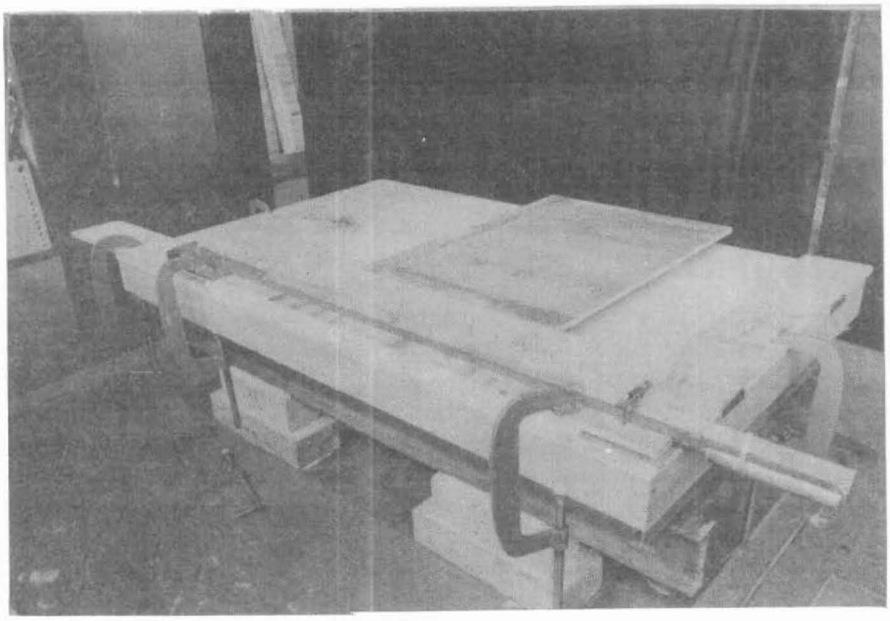


FIG.5.11. Single cramp used on the top and bottom layers of an M_2 element.

This force was sufficient to ensure that any bow in the boards was overcome although when the cramps were removed after a layer had been nailed to the one beneath, the nails were unable to prevent some separation of adjacent boards in extreme cases. A steel template shown in figure 5.12 was used to align the adjacent layers accurately at right angles and also served as a guide for drawing pencil lines for the nailing pattern.

For nail-glued elements the middle and top layers were aligned, cramped and braced with a length of slotted angle iron screwed to each alternate board as shown in figure 5.12. Those nails whose positions were not obscured were then started and the layer lifted clear so that a measured quantity of glue could be spread on the layer beneath. The upper layer was then replaced, realigned and nailed.

For the compression and shear elements a similar jig was used measuring 3 X 8 ft. Mechanical sash cramps were used instead of the hydraulic cramps, a known force being obtained by using a torque wrench on the screw.

In all other aspects the procedure followed was the same as for the flexure elements.

The assembling was done in the laboratory and took one to two hours, after which each element was returned to the constant temperature room for a minimum of one week before being trimmed to size.

The compression and torsion elements were trimmed with the apparatus shown in figure 5.13 which consisted of the table used to construct those elements with a guide to carry a portable power saw straight and at right angles to the table.

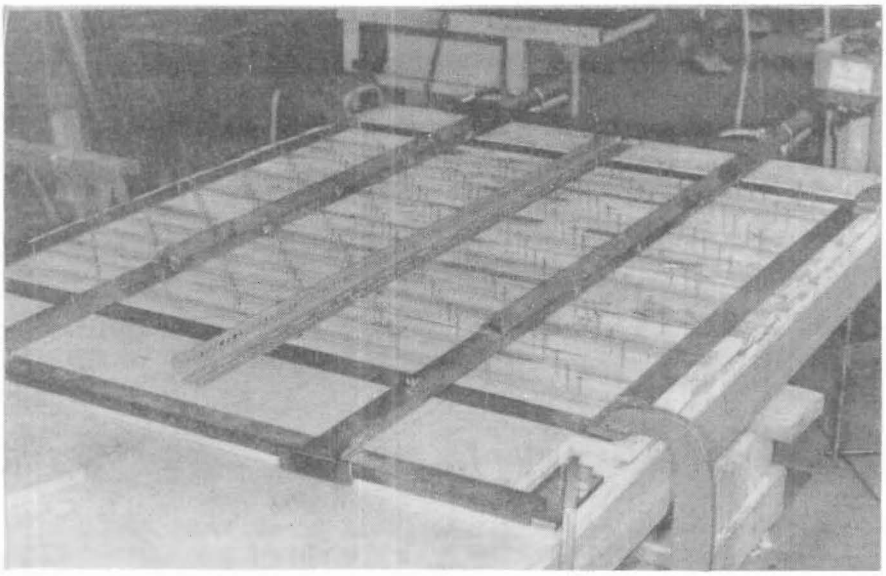


FIG.5.12. Top layer of a nail-glued torsion element cramped and braced with a length of slotted angle and a steel template before lifting for glue placement.

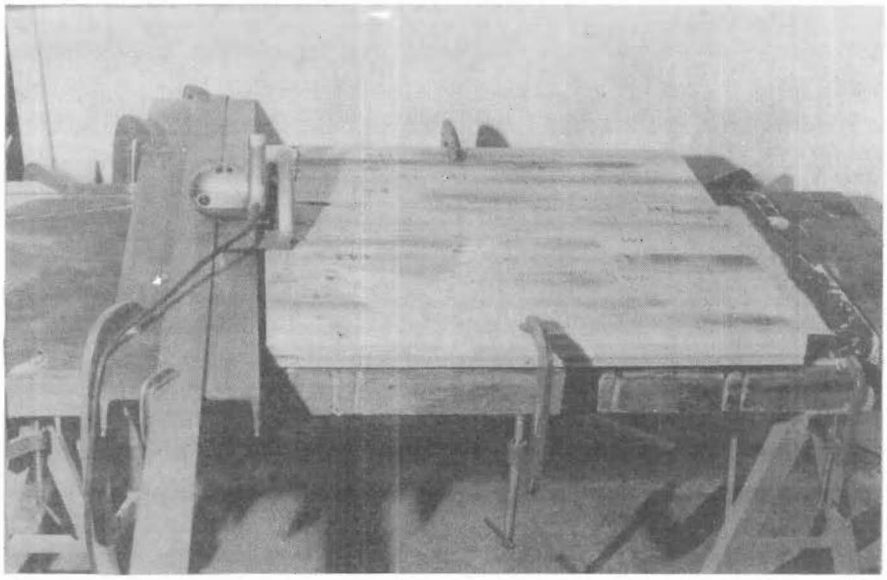


FIG.5.13. Compression element being trimmed square and to size.

The elements were trimmed to lines scribed around the template used in their construction. The bending elements were not trimmed as the $\frac{1}{2}$ to 1 in. excess length did not interfere with the loading rig and also, as the nailing density was the number of nails in an area of one board width times one board width, the removal of a small amount of timber would not be as insignificant on these narrow elements as it was on the torsion elements. This trimming took about $\frac{1}{2}$ hour per element after which they were returned to the constant temperature room and tested two to ten weeks later.

5.3.2 Testing

5.3.2.1 Compression - Actions T_1 and T_2

The rig developed to apply actions T_1 or T_2 to an element is shown in figure 5.14.

It consisted of two reaction beams 7 ft apart vertically, fixed between two columns 5 ft apart. Figure 5.15 shows the hydraulic ram at the centre of the lower reaction beam acting at the centre of a short beam which in turn acted on the lower distribution beam at two points 20 in. apart. This distribution beam carried rollers on its machined upper surface to accommodate lateral in-plane movement relative to the element. To a $\frac{3}{8}$ X 3 in. plate above the rollers was fixed a brass strip with a $1\frac{1}{2}$ in. radius groove along it. Half round steel pieces 9 in. long and with a $1\frac{1}{2}$ in. radius fitted into the grooved brass strip and transferred load to the lower edge of the element through a 1/16 in. thick rubber packing. The distribution beam was constrained to move vertically by means of roller bearings and guides at each end. A similar arrangement of half round steel pieces and grooved brass strip but without the rollers transferred the load from the element to the upper

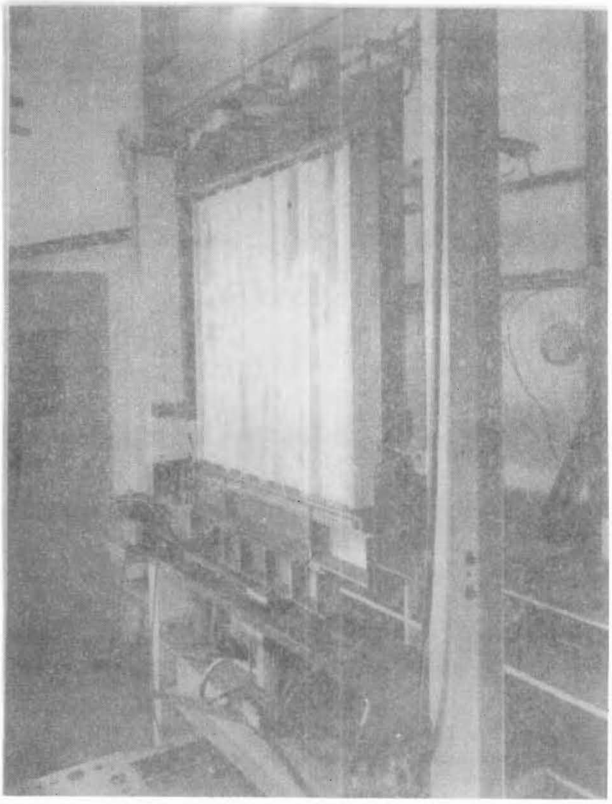


FIG.5.14. Compression test rig with an element under action T_1.

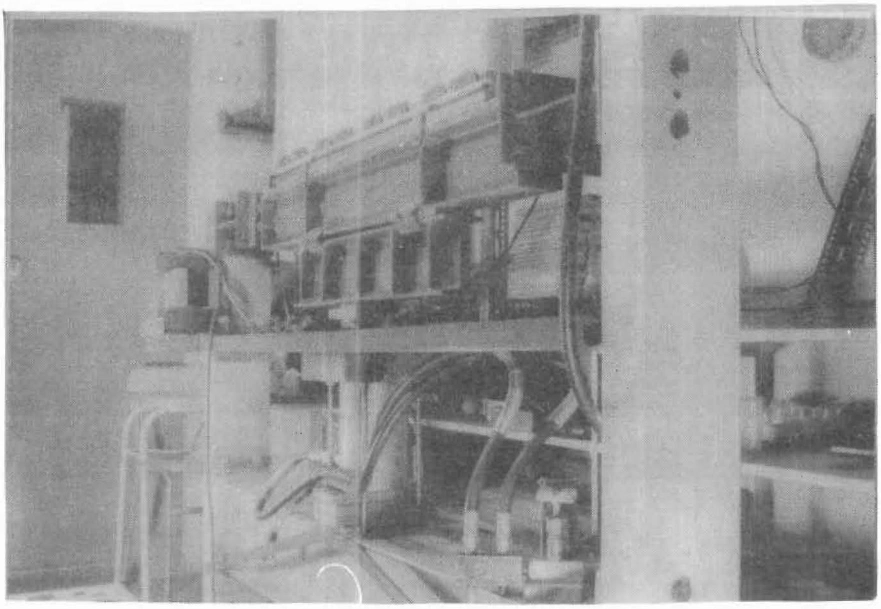


FIG.5.15. System of load application to lower edge of element.

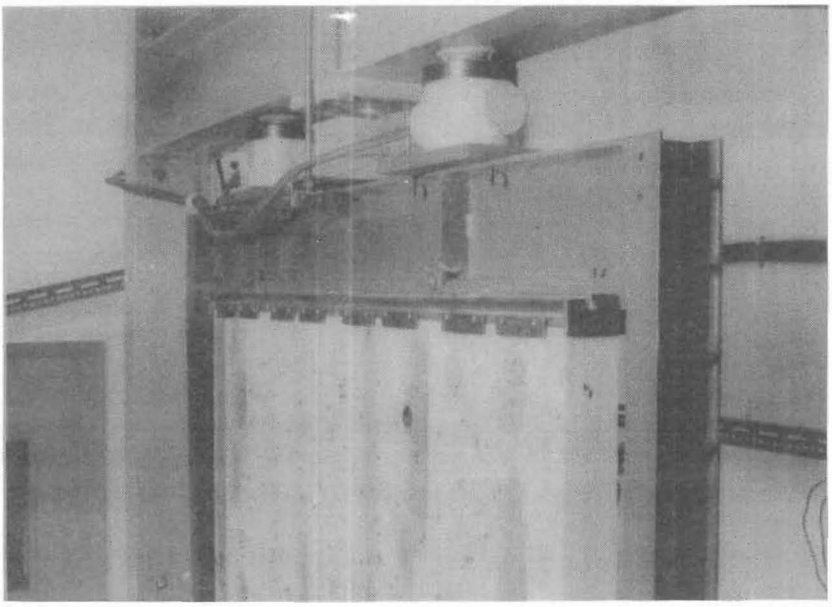
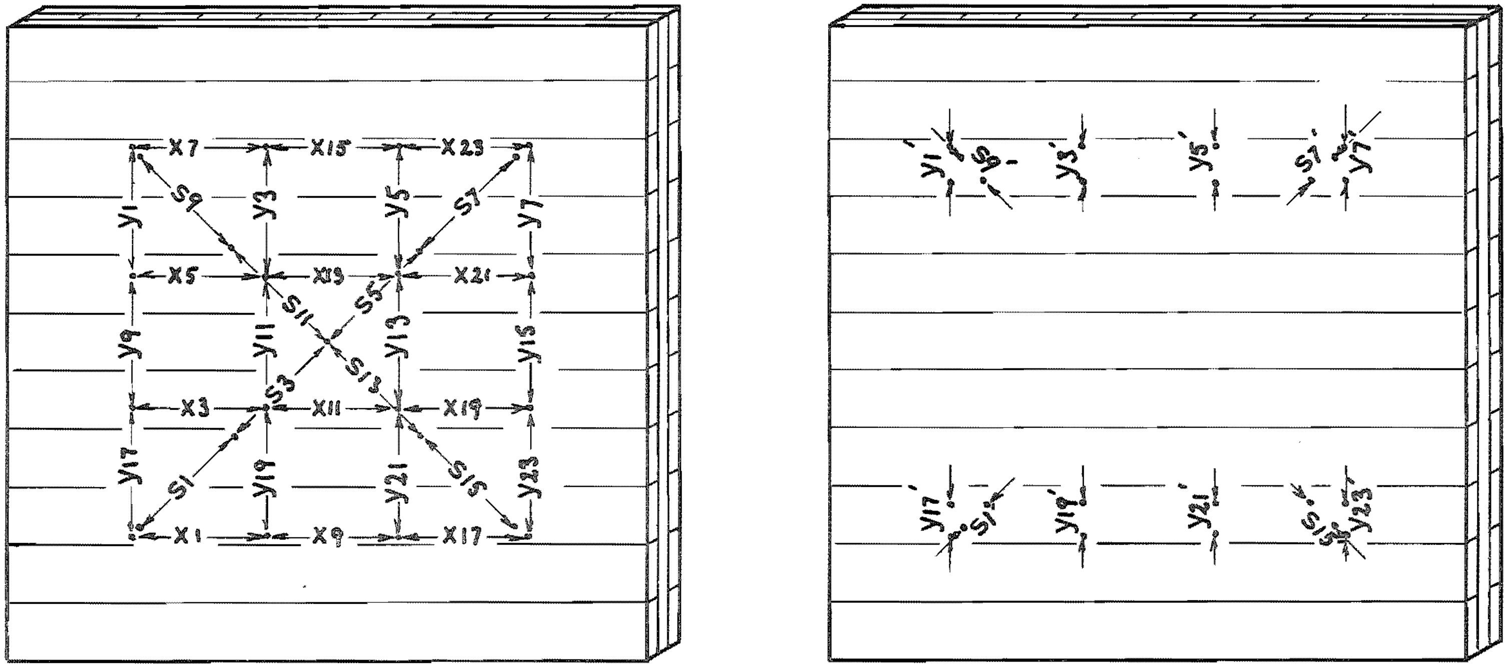


FIG.5.16. Upper distribution beam and load cells in compression test rig.

distribution beam which was also constrained to move vertically. A Budd strain indicator connected to two compression load cells placed 10 in. either side of centre measured the load transferred to the upper reaction beam as shown in figure 5.16.

A Rheile oil pressure machine connected to the hydraulic ram was remotely controlled from within the constant temperature room to apply the loads measured at the load cells.

Strains were measured on both sides of the elements with 8 in. and 2 in. gauge length Demec mechanical strain gauges. Two series of elements were tested: in series I, 8 in. gauges were used in the pattern shown in figure 5.17a, while in series II, additional 2 in. gauges were used as in the pattern shown in figure 5.17b. The gauge positions were numbered as shown with the odd numbers on the nail head side and the successive even numbers immediately opposite on the nail point side. The need for the second series of tests arose from the observation in the shear tests that each board moved relative to the adjacent ones, i.e. the element behaved more as a mechanism than as a homogeneous unit. This behaviour affected the strains observed along the diagonals in that the strains at positions S_{11}, S_{12}, S_{13}, and S_{14} were from 1.5 to 2.0 times the strains at positions S_9, S_{10}, S_{15}, and S_{16}. In other words, with the shear deformation appearing primarily as slip between adjacent boards, since gauges S_{11} to S_{14} spanned two board interfaces, they observed approximately twice the strain observed by gauges S_9, S_{10}, S_{15}, and S_{16} which spanned only one board interface. The same effect occurred in gauges S_1 to S_8. Thus it was necessary to relate the displacement observed in a particular direction to a gauge length which was an integral multiple of the board centreline-to-centreline



(a) 8in. Demec gauge pattern

(b) 2in. Demec gauge pattern

FIG.5.17. Pattern of Demec gauge points and labelling on nail head side of elements tested under actions T_1 , T_2 and S.

distance in that direction to obtain a strain which would relate to the element as a whole.

Therefore for gauge lines in the diagonal direction, e.g. gauge line S_1 to S_7 as shown in figure 5.18, the strains relative to gauge length A-B were calculated by:

$$AB = \frac{32\,\varepsilon_8 - (32 - 6b\sqrt{2})\,\varepsilon_2}{6b\sqrt{2}} \quad \ldots\ldots\ldots\ldots \quad [5.20]$$

where ε_8 = average strains at S_1, S_3, S_5 and S_7,

ε_2 = average strains at S_1', and S_7',

and b = board width = 3.5 in.

From equation [5.20] it is seen that if the deformation occurs entirely as slip between adjacent boards, i.e. if $\varepsilon_2 = 0$, then the shear strain according to the 8 in. gauges only would be underestimated by 7.2 per cent.

It was also possible that a similar effect could occur in the Y direction in which case the strains relative to gauge length A-B were calculated by:

$$AB = \frac{(24\,\varepsilon_8 - (24 - 6b)\,\varepsilon_2)}{6b} \quad \ldots\ldots\ldots\ldots \quad [5.21]$$

where ε_8 = average strains at Y_1, Y_9 and Y_{17},

ε_2 = average strains at Y_1' and Y_{17}',

and b = board width = 3.5 in.

Another effect was noted and a correction made for it. This was that the average strains on the two sides of an element under action T_1 or T_2 were often unequal. This unequality was possibly due to eccentric loading, dissimilar properties in different boards, or the

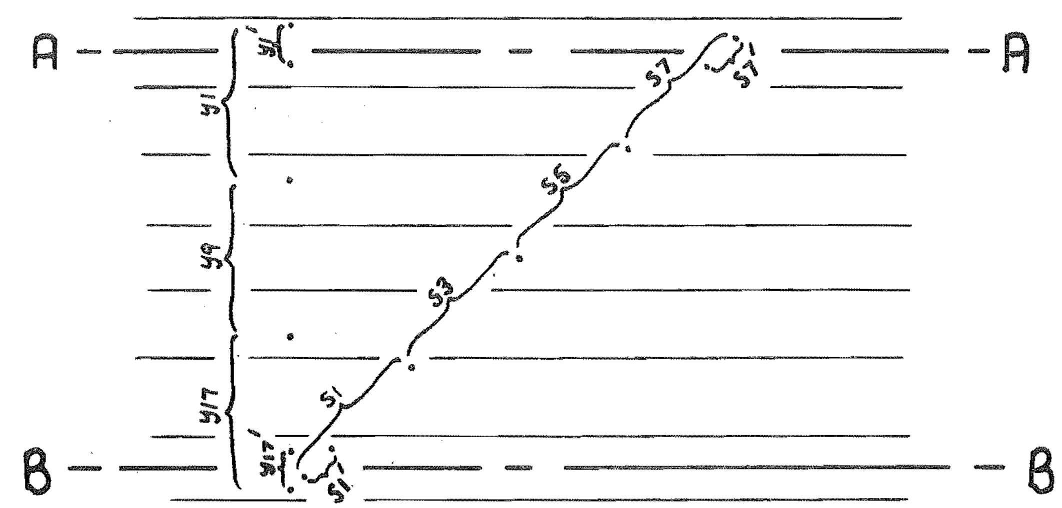


FIG.5.18. Gauge positions S1-S3-S5-S7 and Y1-Y9-Y17 on prototype elements tested under actions T_1, T_2 and S.

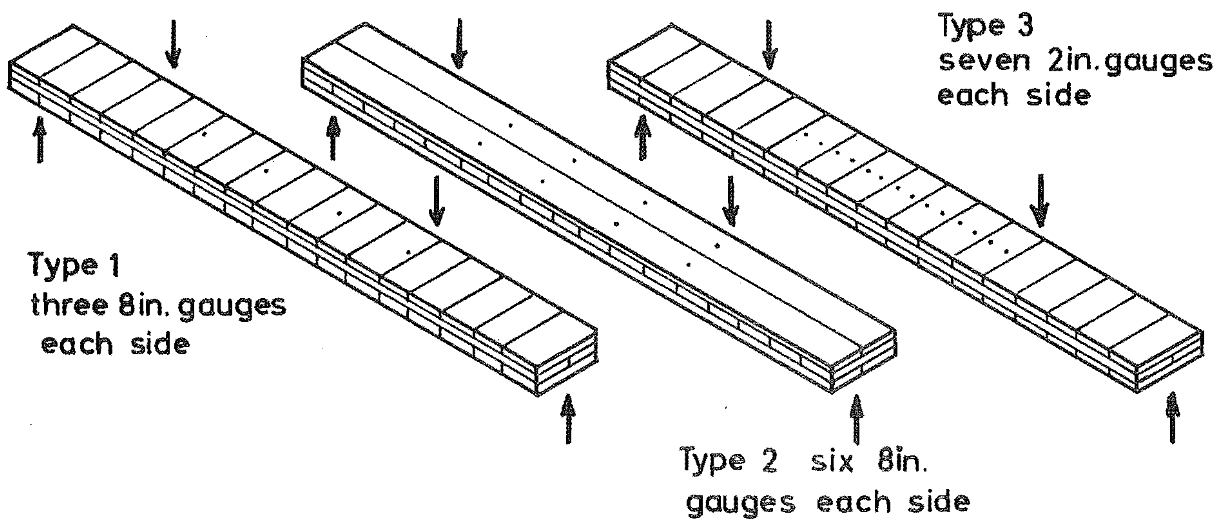
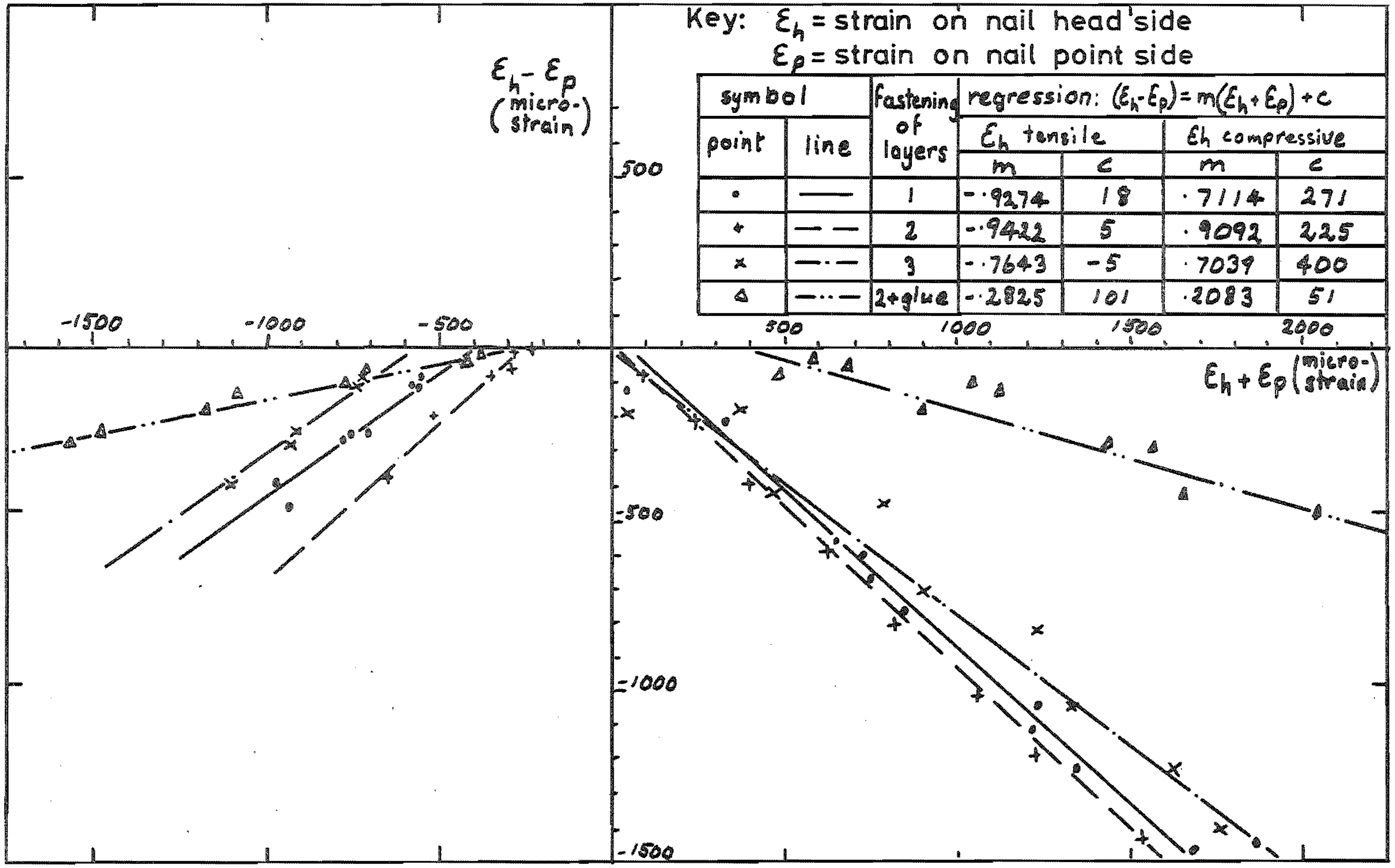


FIG.5.19. Gauge positions on elements tested in bending to determine a correction for bending effects in compression tests.

unsymmetrical construction resulting from nailing from one side only and using two sizes of nails. For strains $\mathcal{E}_x$ under action T_1 and for strains $\mathcal{E}_y$ under action T_2, the average ratio of the difference between the strains on the two sides to their mean was 0.62:1. Also under action T_1 two thirds of the elements showed greater compressive strains on the nail head side while under action T_2 the same proportion showed greater compressive strains on the nail point side.

To determine the required correction it was assumed that eccentric loading was being applied, thus inducing bending in the elements. A total of ten elements in the three types shown in figure 5.19 were constructed and tested in bending. Elements of type 1 and 2 contained nailing patterns 1 and 3 and nail-gluing, while all four means of fastening were covered in type 3. The strains observed over the 8 in. gauge lengths on types 1 and 2 were essentially equal and opposite on the two sides. For type 3, however, as tensile stress could not be transmitted between the boards on the tensile face, the strains on this face showed only low tensile values which did not increase once the initial compressive stress due to cramping had been overcome. This produced the relationships between the strains on the two sides shown in figure 5.20. Thus, if a 2 in. gauge length strain was tensile, correction was made assuming the regression equations given in figure 5.20.

The uniformity of the load applied by the rig was tested by means of an element 36 X 36 X $2\frac{1}{4}$ in., constructed of three layers of $\frac{3}{4}$ in. thick medium density particle board glued together. This element was assumed to be homogeneous and isotropic. Eight inch gauge length strain



Key: ε_h = strain on nail head side
ε_p = strain on nail point side

symbol: point	symbol: line	fastening of layers	regression: $(\varepsilon_h-\varepsilon_p)=m(\varepsilon_h+\varepsilon_p)+c$ — ε_h tensile: m	ε_h tensile: c	ε_h compressive: m	ε_h compressive: c
•	——	1	-·9274	18	·7114	271
+	— —	2	-·9422	5	·9092	225
×	—·—	3	-·7643	-5	·7039	400
△	—··—	2+glue	-·2825	101	·2083	51

FIG.5.20. Relationships between strains at 2in. gauge positions on nail head side and nail point side of elements tested in bending.

gauges were used and these indicated the pattern of strains shown in figure 5.21 and tabulated in table B.2 in the appendix. The strain pattern could possibly have been improved by stiffer distribution beams but in view of the non-homogeneous and variable elements being tested the pattern was considered satisfactory.

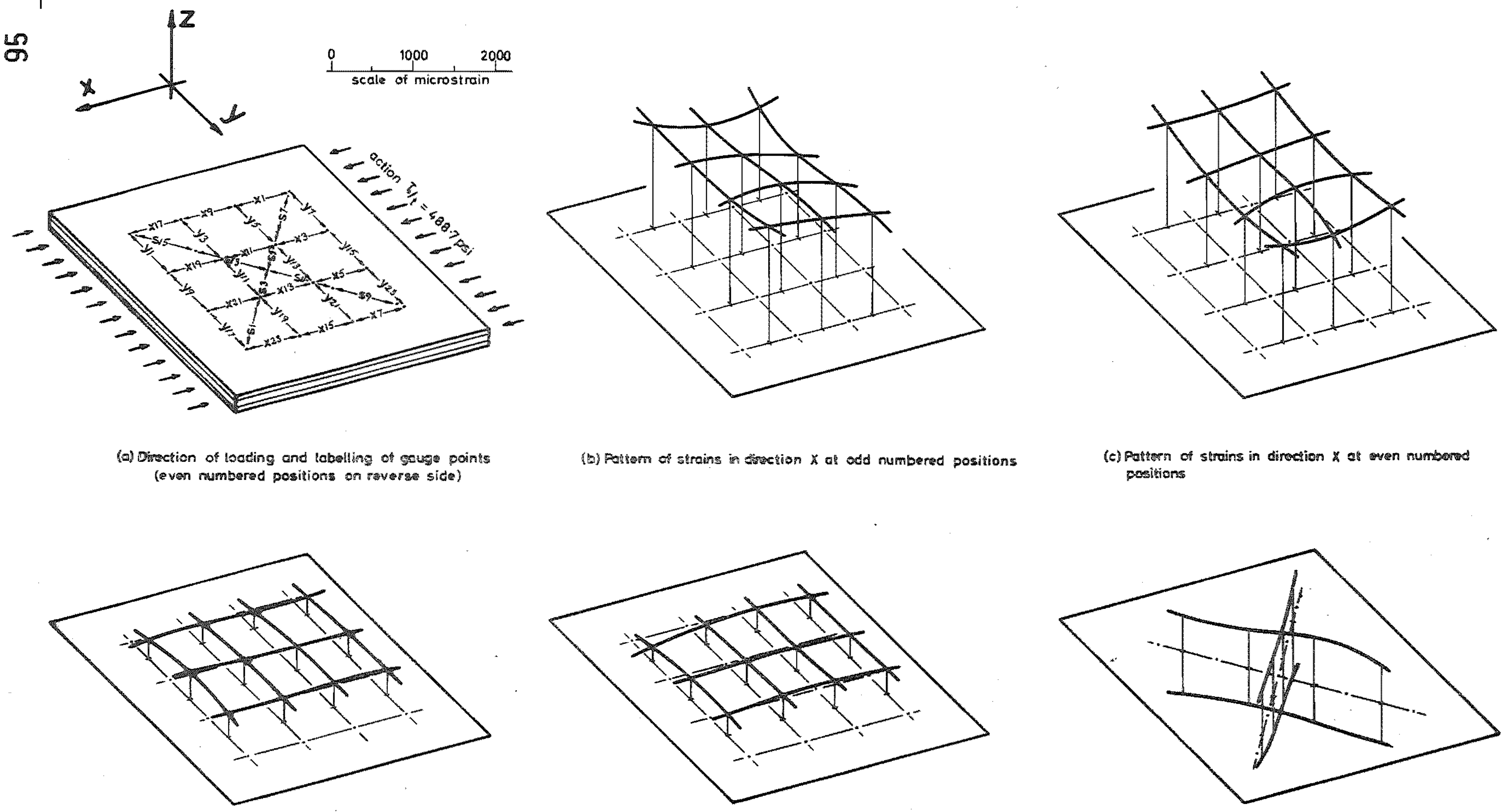
To determine the buckling loads of elements under this loading and, from this, safe working loads for the remainder of the elements, four elements were made and loaded to failure as shown in figure 5.22.

Half round steel pieces were used on the loaded edges as described previously. Although oil was spread on the cross strips to give pin-ended conditions, friction probably introduced some fixity. These elements, of which details are given in table 5.2 were tested under action T_2 and then action T_1.

TABLE 5.2 Details of elements tested for buckling in edgewise compression

ELEMENT LABEL	FASTENING OF LAYERS	GRADING MODULUS		BUCKLING STRESSES		REMARKS
		MEAN ($X10^6$psi)	C. OF V. (%)	T_1/t (psi)	T_2/t (psi)	
54	pattern 1	.904	15	820	539	
14	pattern 2	.963	12	-	611	Element fractured under action T_2
24	pattern 3	.913	13	1089	508	
34	pattern 2 and glue	.985	13	>2581	968	Capacity of test machine reached under action T_1

On the basis of these tests maximum values of T_1/t and T_2/t of 480 and 240 psi respectively were used in the compression tests on both prototype and model elements.



(a) Direction of loading and labelling of gauge points (even numbered positions on reverse side)

(b) Pattern of strains in direction X at odd numbered positions

(c) Pattern of strains in direction X at even numbered positions

(d) Pattern of strains in direction Y at odd numbered positions

(e) Pattern of strains in direction Y at even numbered positions

(f) Pattern of strains in diagonal directions

FIG.5.21. Patterns of strain on particle board element used to check compression rig for uniformity of loading.

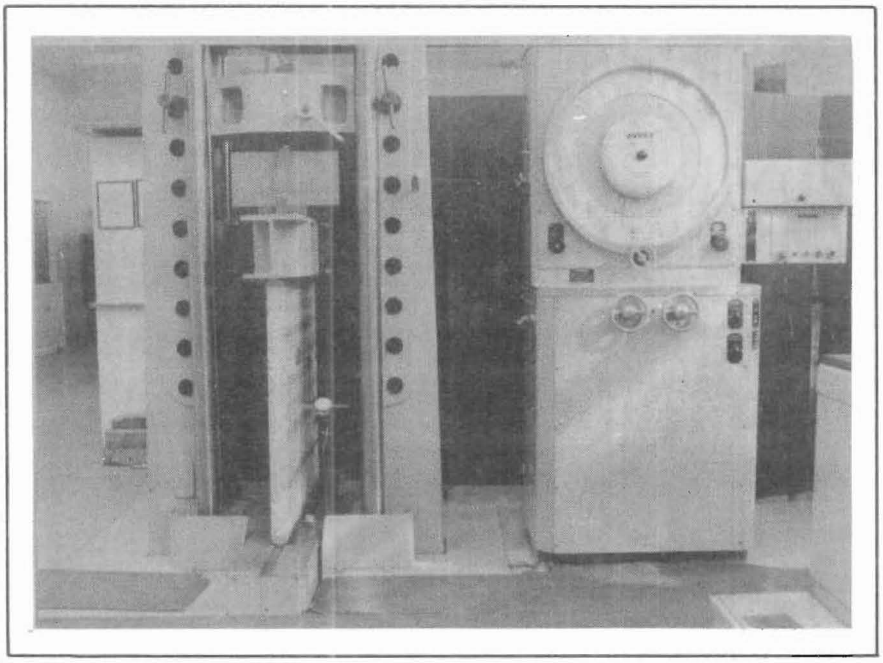


FIG.5.22 Buckling tests on prototype elements under actions T_1 and T_2.

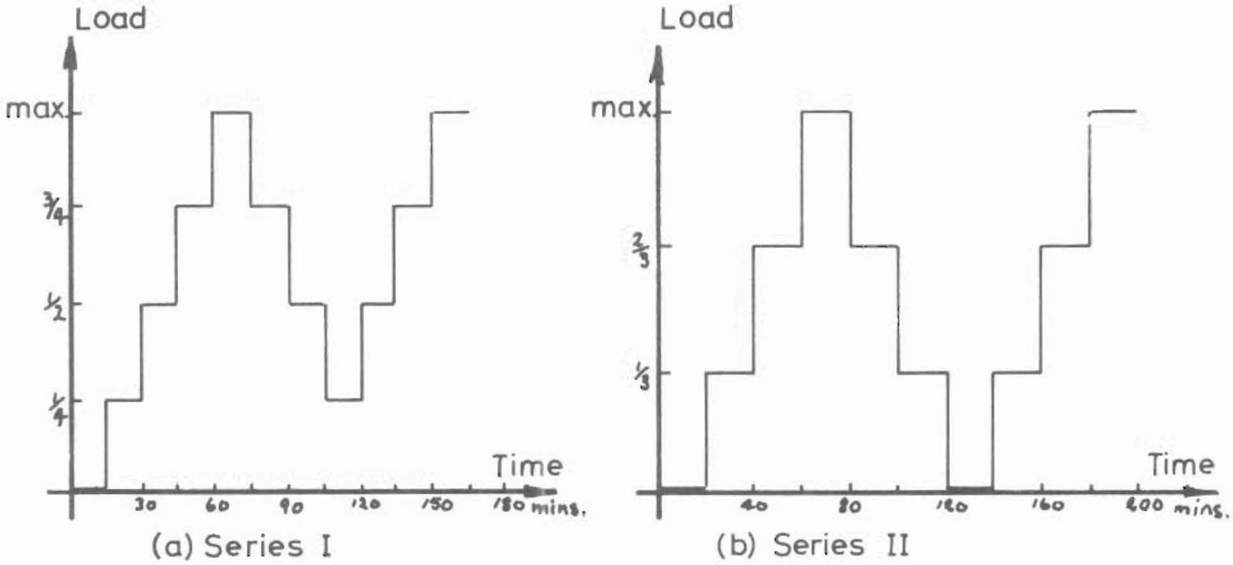


FIG.5.23 Load-time schedules for prototype elements under actions T_1 and T_2.

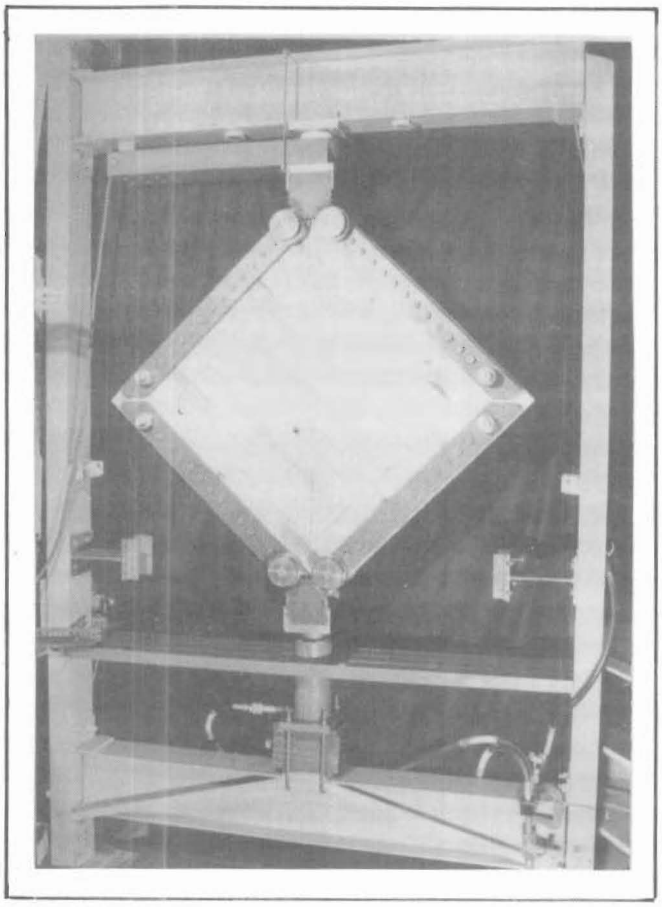


FIG.5.24. Rig to apply action S to prototype elements.

Loading procedures similar to that for the nailed joint tests were adopted for these tests as shown in figure 5.23.

A longer period between increments was necessary in series II to allow for the reading of the additional 2 in. gauges.

The sequence of reading of the load cells and strain gauges was as follows for each increment:

(i) The required load change was effected except for the beginning of a test when zero load readings were taken.

(ii) Five minutes after each load change, reading was commenced starting with the load cells. Referring to figure 5.17, these were followed by the 8 in gauge zeros, gauge positions X_1, X_2, --- to X_{24}; Y_2, --- to Y_{24}; S_1, S_2, --- S_{16} and the 8 in. gauge zeros again.

(iii) For series I the load cells were re-read and the readings in step (ii) retaken in reverse sequence. For series II the 2 in. gauge zeros, gauge positions Y'_1, Y'_2, --- Y'_8; Y'_{17}, Y'_{18} --- Y'_{24}; S'_1, S'_2, S'_7, --- S'_{10}, S'_{18} and S'_{16}, the 2 in. gauge zeros and the load cells were read and then reread in reverse sequence followed by those of step (ii) in reverse sequence.

By re-reading, a check for misreading was made, also some correction for creep during the period between readings was obtained by averaging the two readings. It was found, however, that in the compression tests the creep was less than could be detected by the 8 in. Demec gauges.

5.3.2.2 Shear - Action S

The rig constructed to apply action S is shown in figure 5.24. The same basic frame as for the compression tests carried a smaller capacity

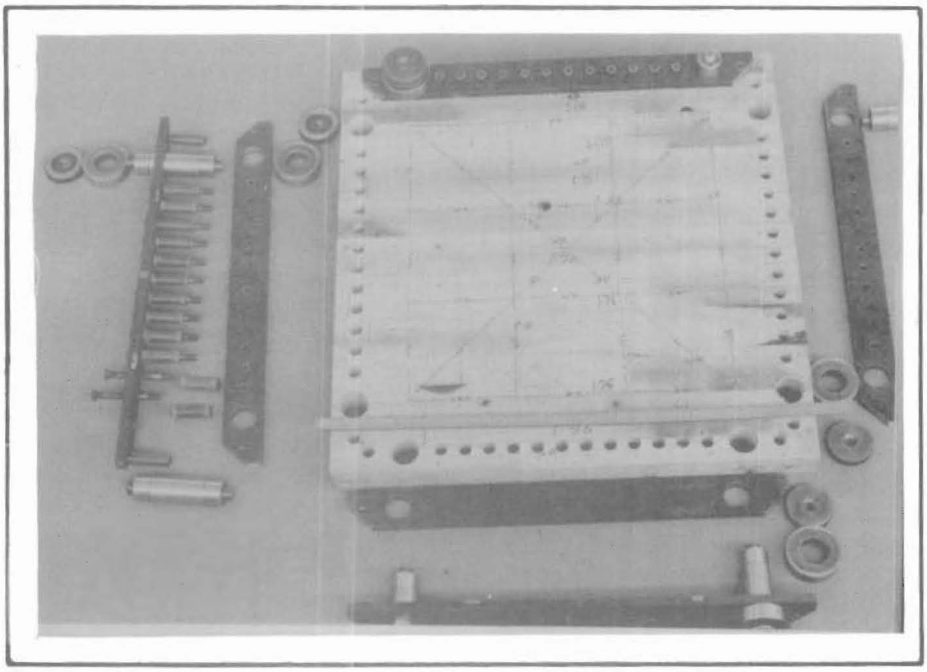


FIG. 5.25 Showing assembly of shear apparatus on prototype element.

hydraulic ram centrally on the lower reaction beam. This ram carried a Vee-block which could tilt slightly on a knife edge lying in a horizontal axis perpendicular to the plane of the element. This allowed even distribution of load between the two sides of the element. A similar Vee-block at the top transmitted the load to a load cell through a steel ball and was prevented from rotating about an axis normal to the plane of the element by a channel section beam hinged to the top reaction beam. The Vee-blocks acted on bearings carried on 2 in. diameter axles to apply loads axially to the straps bolted to the four edges of the element. The bolts transmitted the load to the element through rubber bushes shown in figure 5.25. The bushes were a neat fit on the $\frac{1}{2}$ in. diam. bolts and undersize in the 15/16 in. diam. holes drilled in the element but were long enough so that as the bolts were tightened the bushes expanded to fit tightly and hold the straps 1/16 to 1/32 in. clear of the element. The holes for the bushes and axles were located along the sides of a 32 in. square at positions determined by means of the template used during construction of the elements.

This rig was designed to apply uniformly distributed loads along the edges of a square element without restraining the deformation which occur in nailed elements. In this latter respect it is considered that the rig used by Lee described in section 5.1 with its glued-on hardwood blocks seriously influences the behaviour of the nailed element by preventing relative slip between adjacent boards in the outer layers.

Strains were measured on both sides of the elements using 8 in. and 2 in. Demec gauges and the same gauge patterns and reading sequence as in the compression tests, except that there was only one load cell to read instead of two.

The particle board element used to test the uniformity of load applied by the compression rig was also used to test the shear rig. The pattern of strains observed is shown in figure 5.26, and tabulated in table B.2. Although strains in directions X and Y occurred at the corners, it was considered that these corner disturbances were comparatively small and since a boarded element is far from homogeneous, no alteration was made to the rig.

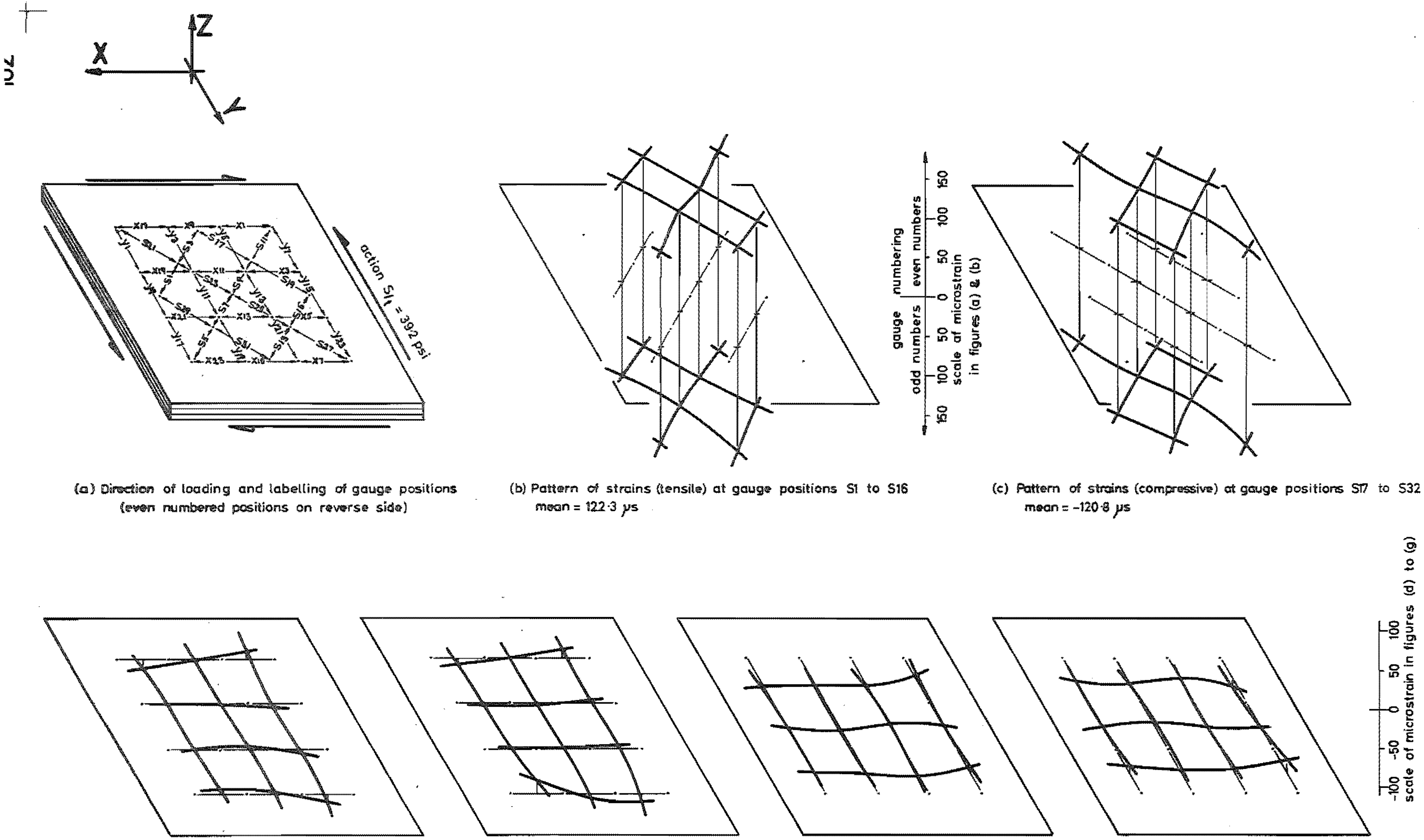
Six trial nailed elements were made and tested in shear to determine a suitable loading schedule. These gave stress-strain curves of similar shape to the mean load-slip curve for prototype nailed joints as shown in figure 5.27. From these curves it appeared that the point on the load-slip curve at which the load cycle commenced corresponded to points on the stress-strain curves between about 700 and 1000 microstrain. A further two elements were made and tested with load increments applied at 20 min. and 30 min. intervals respectively. Strains were observed only at gauge positions S_1 to S_{16} to give the strain-time curves shown in figure 5.28 from which it was seen that creep of more than 5% in 20 min. occurred above 1500 microstrain. On the basis of this work it was decided that the load cycle should commence at a strain of about 1000 microstrain.

The load-time schedules adopted for the two series are shown in fig. 5.29, where the load P was calculated to produce 1000 microstrain.

For the glued elements the load-time schedules were the same as those for the compression tests shown in figure 5.23 with the maximum load calculated to produce 1000 microstrain shear strain.

5.3.2.3 <u>Bending - Actions M_1 and M_2</u>

The rig shown in figure 5.30 applied symmetrical four-point loading to elements 7 in. wide over a 58 in. span. It consisted of a reaction



(a) Direction of loading and labelling of gauge positions (even numbered positions on reverse side)

(b) Pattern of strains (tensile) at gauge positions S1 to S16 mean = 122·3 μs

(c) Pattern of strains (compressive) at gauge positions S17 to S32 mean = −120·8 μs

(d) Pattern of strains in direction X on near side mean = −0·8 μs

(e) Pattern of strains in direction X on reverse side mean = 1·7 μs

(f) Pattern of strains in direction Y on near side mean = −0·1 μs

(g) Pattern of strains in direction Y on reverse side mean = 2·7 μs

FIG. 5.26 Patterns of strain on particle board element in test of shear rig for uniformity of loading.

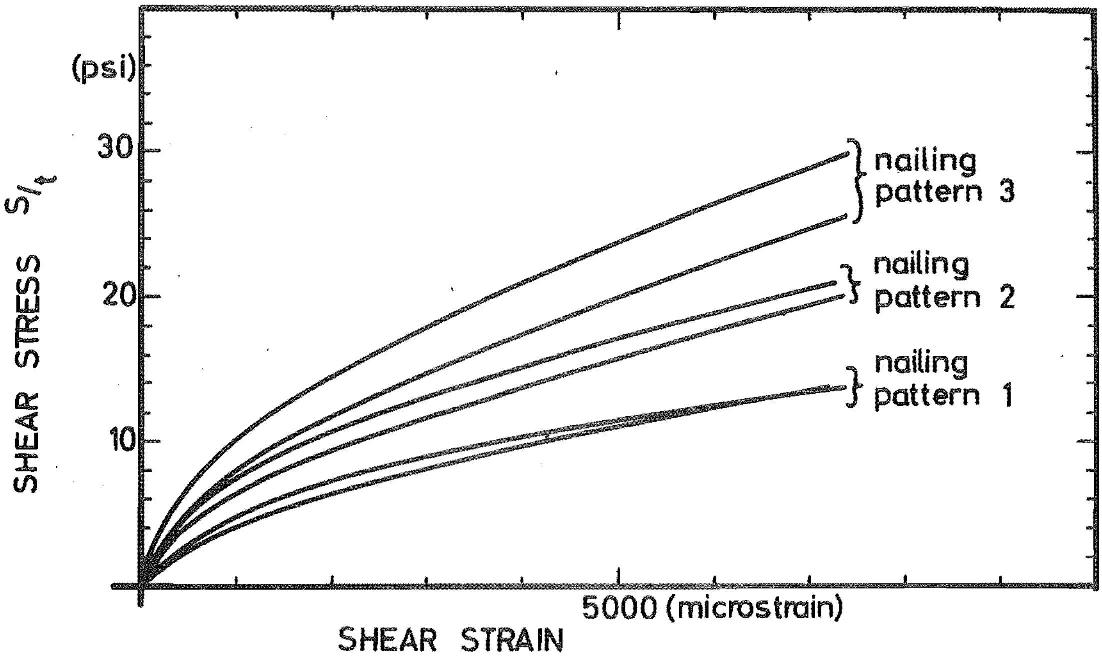


FIG.5. 27 a Shear stress - shear strain curves for six trial prototype nailed elements

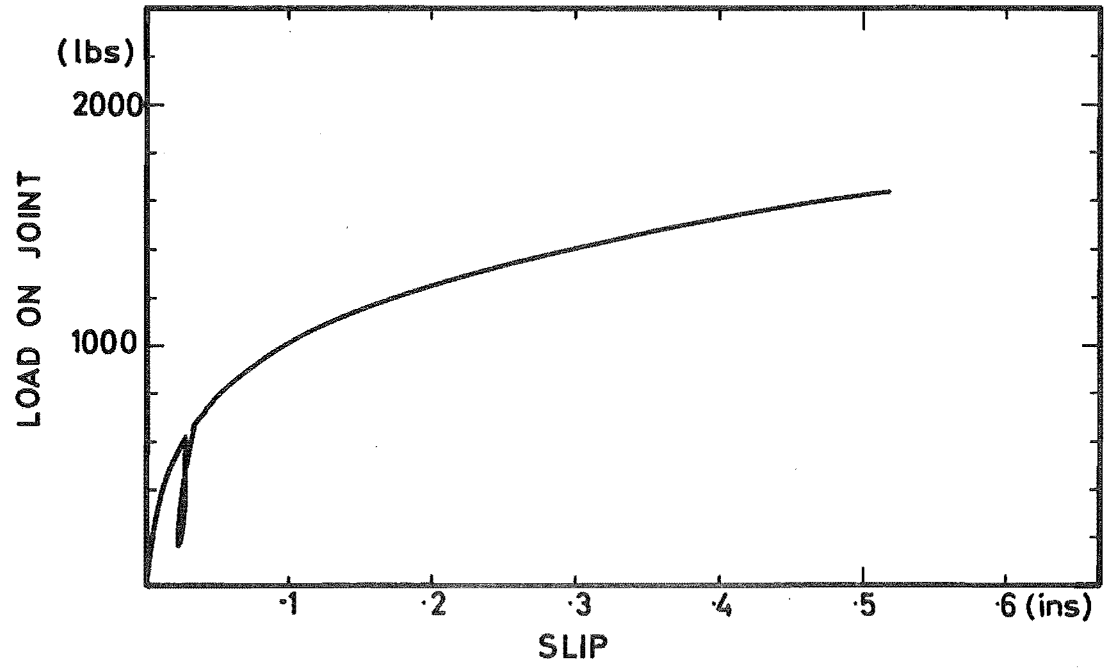


FIG.5.27 b Average load-slip curve for prototype nailed joints.

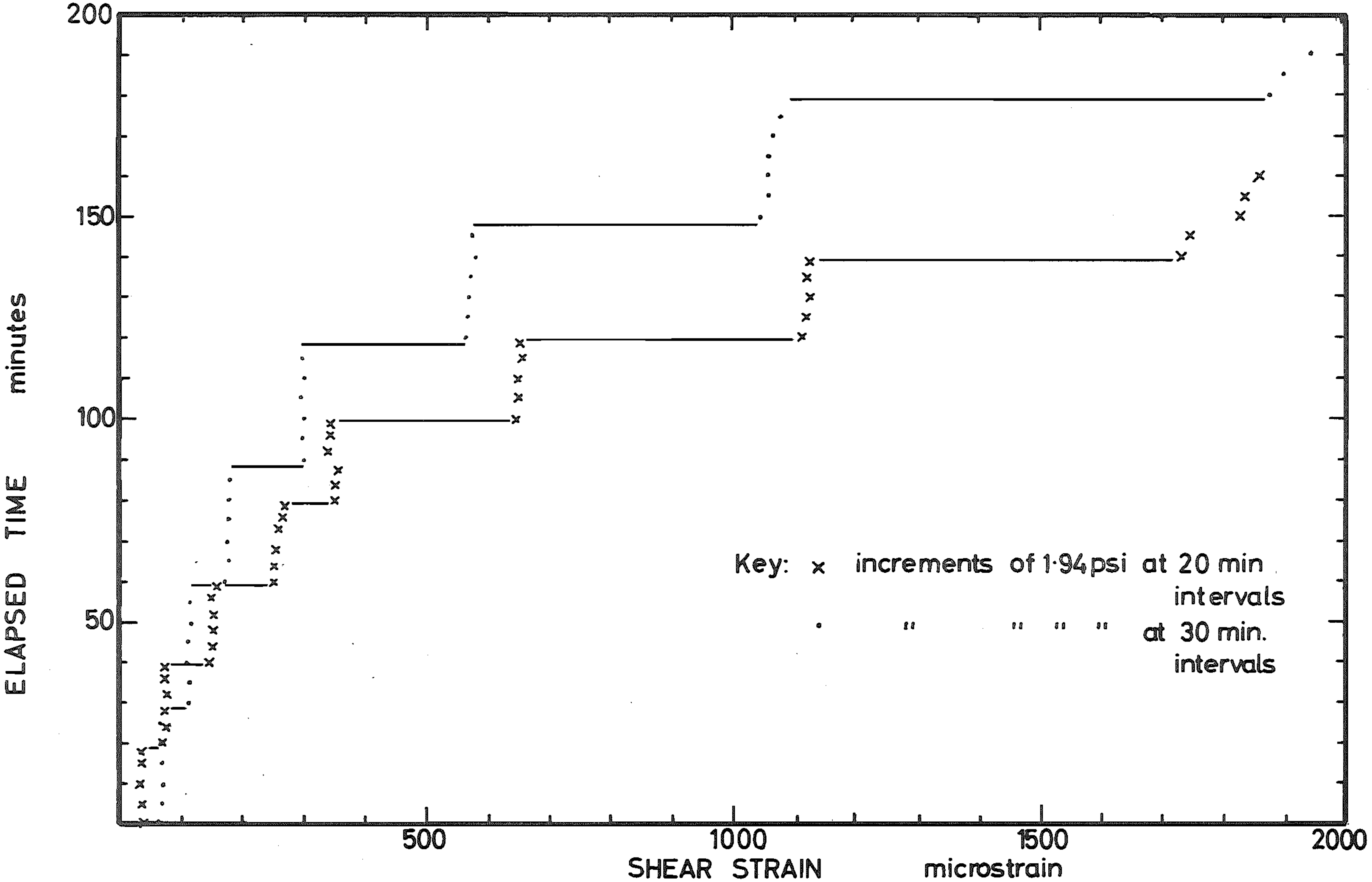


FIG.5.28. Time-strain curves for two nailed prototype elements with nailing pattern no. 3 tested under action S.

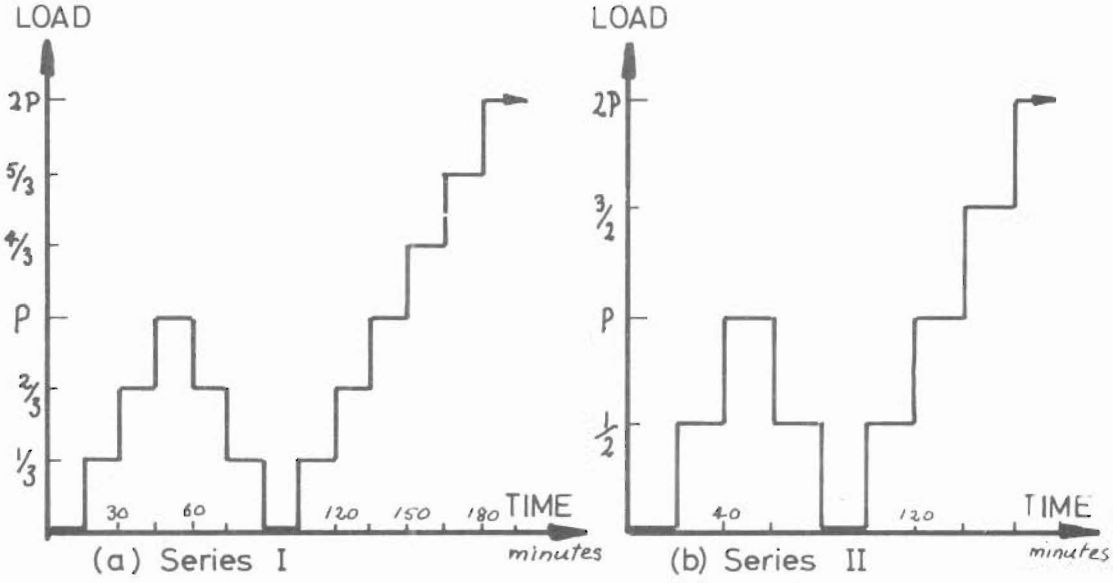


FIG.5.29. Load-time schedules for nailed elements in shear.

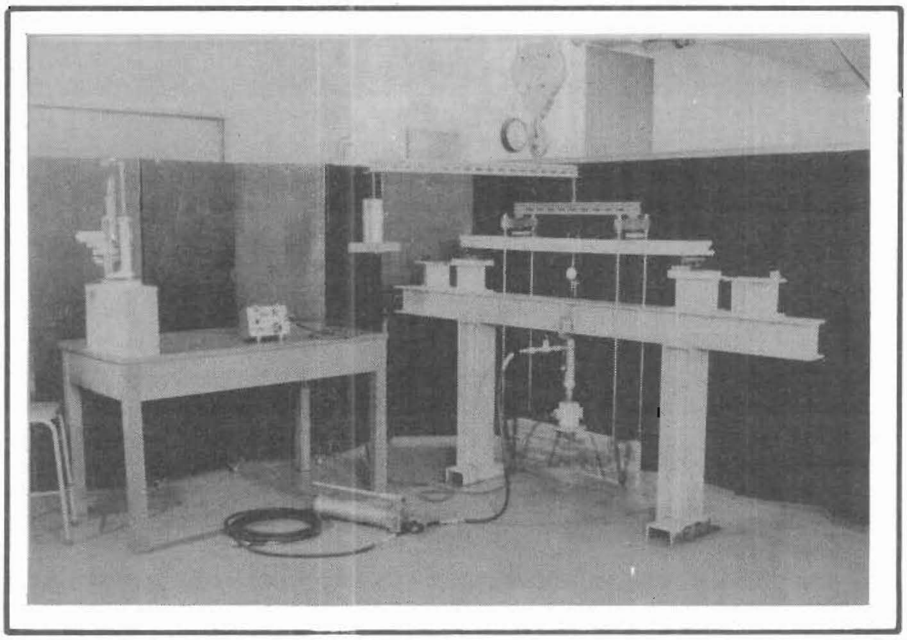


FIG.5.30. Apparatus to apply action M_1 or M_2 to prototype elements.

beam supported on two columns with two short pillars carrying the support rollers, one of which could tilt transversely to allow for twist in the element. Load was applied by a hydraulic ram acting vertically downwards beneath and at the centre of the reaction beam through a 1 ton capacity load cell on a distribution beam. This transmitted the load via hangers to two rollers, 30 in. apart, which could also tilt transversely. Bearing plates $\frac{1}{8}$ X $1\frac{1}{2}$ X 7 in. were placed between the element and each roller. A counterbalance held the loading system against the ram with a constant force so that as the ram retracted the load rollers lifted clear of the element. The load was measured to an accuracy of ± 1 lb by means of a Budd strain indicator connected to the load cell. To observe deflections, six targets were placed as shown in figure 5.31 at the centre, and 12 in. either side of the centre longitudinally and $1\frac{3}{4}$ in. either side of centre transversely. Vertical displacement of the target tops was measured with an automatic precise level mounted on a travelling microscope carriage. This apparatus was used by Bryant[(31)] and has been described in detail by him. A dial gauge mounted on the reaction beam bore against a smooth glued-on aluminium plate for a quick indication of central deflection.

The loading procedure shown in figure 5.32 was followed, it being similar to those used previously except that each increment occurred at 10 min. intervals and that constant deflections were imposed instead of constant loads. Although a hydraulic ram was used, constant deflections were effectively obtained by closing a valve in the oil line immediately adjacent to the ram. The first three loading increments produced central deflections of 0.2 in., 0.4 in. and 0.6 in. respectively as observed on the dial gauge. Thereafter increments equal to $\frac{1}{3}$ the load observed at a

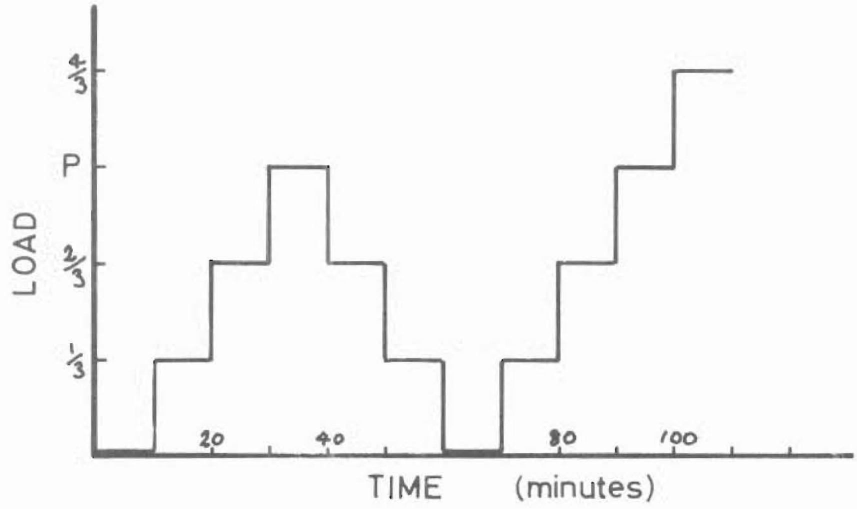


FIG. 5.32 Load-time schedule for prototype elements in bending.

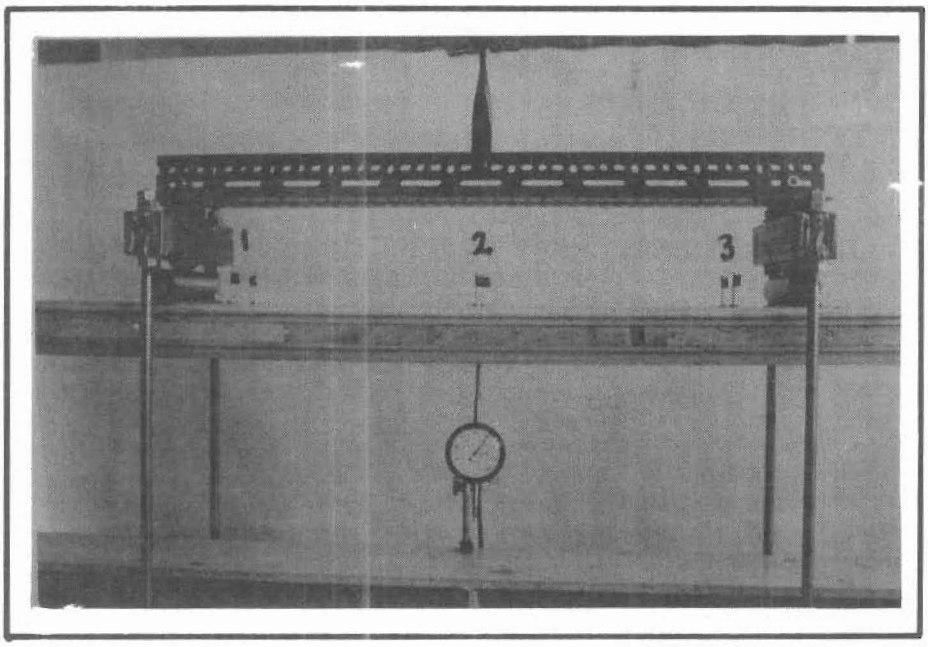


FIG. 5.31. Targets and dial gauge used to measure deflections of prototype elements in bending.

central deflection of 0.6 in. were applied. Readings of the load cell and dial gauge were taken immediately after each load change and again five minutes later followed by the target positions, the dial gauge and the load cell.

5.3.2.4 Torsion - Action H

The rig for the bending tests was modified slightly to apply torsion to elements trimmed $59\frac{1}{4}$ in. square and is shown in figure 5.33. The elements were supported and loaded at the corners through bolted-on steel plates. The supports were horizontal knife edges on rollers which allowed movement parallel to the reaction beam. A hydraulic ram acting vertically beneath the centre of the reaction beam applied load through a 1 ton load cell, a distribution beam, and hangers to steel balls located directly over two diagonally opposite corners. Again a counterbalance lifted the loading system clear of the element when the ram retracted. The nine targets shown in figure 5.34 were placed centrally on the element on a $10\frac{1}{2}$ in. grid parallel to the edges. The automatic precise level and travelling microscope carriage arrangement was used to measure their vertical movements.

The loading and instrument reading procedure was the same as for the bending tests except that the load increments occurred at 5 minute intervals and the first three load applications caused 0.4 in., 0.8 in. and 1.2 in. deflections respectively at the dial gauge mounted on the reaction beam centrally beneath the element.

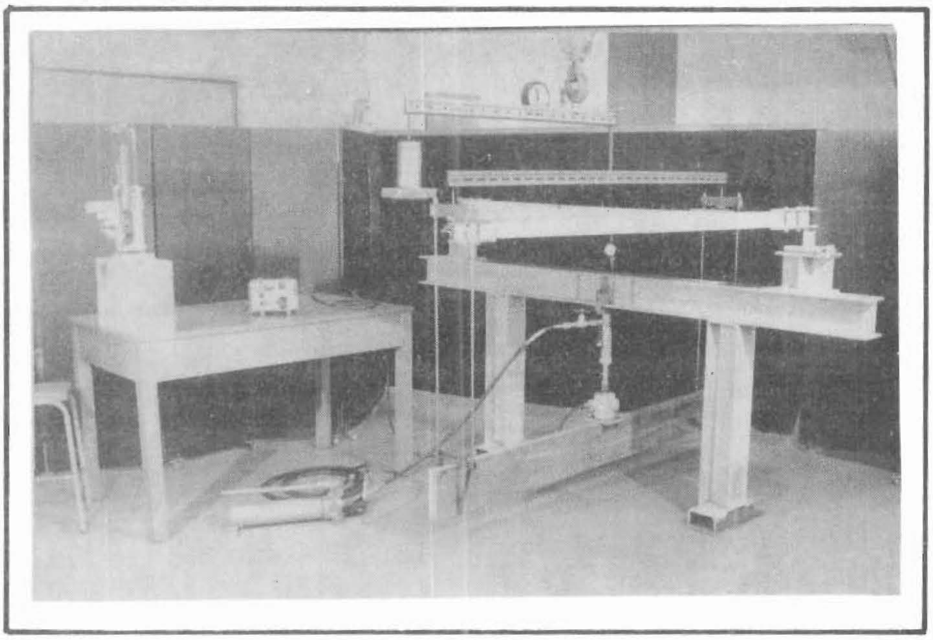


FIG.5.33. Apparatus for testing prototype elements in torsion.

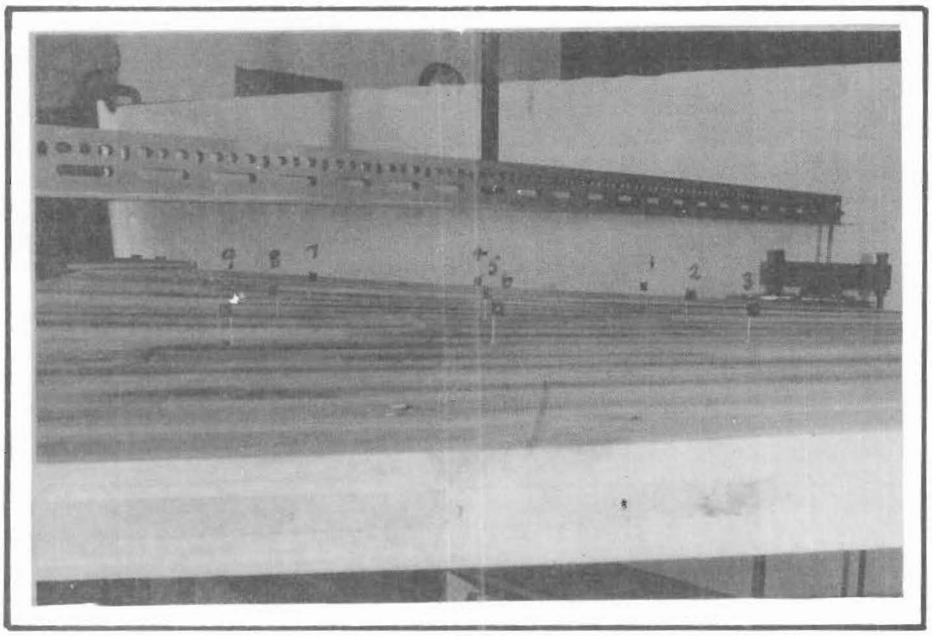


FIG.5.34. Targets placed at $10\frac{1}{2}$ inch centres on a prototype torsion element for deflection measurement.

5.4 RESULTS

5.4.1 Compression and Shear

5.4.1.1 Data Processing

The data for each test was processed using an IBM 360/44 computer. Routine corrections for zero drift of the strain gauges were applied as well as the gauge factors quoted by the manufacturer for each instrument. The pair of readings for each gauge position were averaged for each increment. Since the second reading was obtained by taking the readings in reverse sequence, the mean values from each pair of readings will refer to the same instant of time if it is assumed that creep occurs at a constant rate during the interval between reading and re-reading. The processed results are tabulated in table B.3 in the appendix.

This processing included the correction for inequality of strains on the two sides of the elements as discussed in section 5.3.2.1.

The mean strains in each of the four directions X, Y, S_1 and S_2 defined in figure 5.35 were then determined for the 8 in. and 2 in. gauge lengths separately. The shear strain was determined by the expression:

$$\gamma_{xy} = \varepsilon_{S_1} - \varepsilon_{S_2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [5.22]$$

where subscripts S_1 and S_2 refer to those directions. In the case of series II data, substitution was made into equations [5.20] and [5.21] for ε_y and γ_{xy} which were then compared with their "uncorrected" values, (as given by the 8 in. gauge strains only) by means of regression analysis to yield the coefficients tabulated in table 5.3. These regression equations were then used to correct the average ε_y and γ_{xy} values from the series I data. The average values of ε_x, ε_y and γ_{xy} at

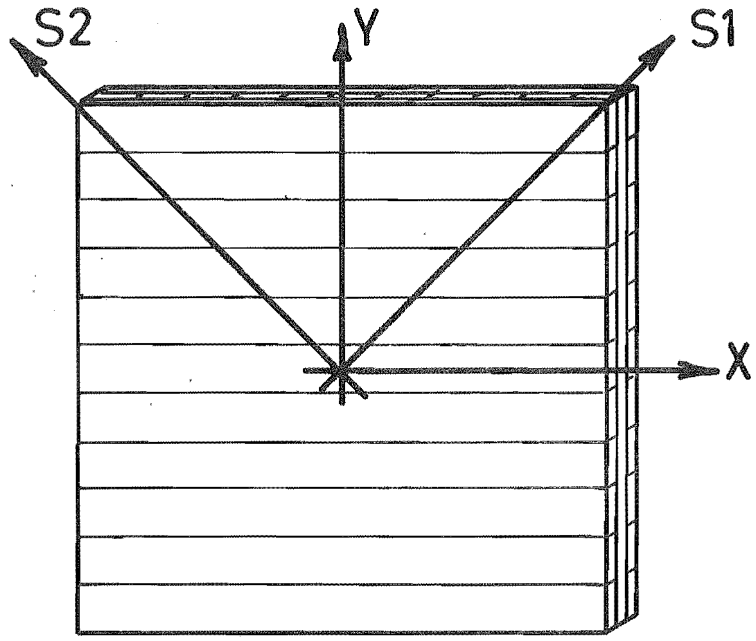


FIG. 5.35. Definition of directions X, Y, S1 and S2 on nail head side of elements.

each level on each element are included in table B.3. The grand average strain-action curves for all elements under each type of action are shown in figures 5.36 to 5.38.

TABLE 5.3 Regression coefficients relating series I and series II data by the equation: (corrected strains) = M (uncorrected strains) + C

ACTION	REGRESSION COEFFICIENT	y		xy	
		NAILED	NAIL-GLUED	NAILED	NAIL-GLUED
T_1	M	0.769	0.811	1.043	1.048
	C (microstrain)	4	4	5	0
T_2	M	1.079	1.080	1.079	0.995
	C (microstrain)	2	9	4	0
S	M	1.053	1.050	1.072	1.035
	C (microstrain)	0	1	-5	1

5.4.1.2 <u>Correlation With Grading Modulus</u>

In order to obtain values for the A_{ij} terms in equation [5.2]:

$$\begin{bmatrix} \varepsilon_x \\ \varepsilon_y \\ \gamma_{xy} \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{23} & A_{33} \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ S \end{bmatrix} \frac{1}{t} \quad \ldots\ldots\ldots\ldots\ldots \quad [5.2]$$

the behaviour of the elements on initial loading and during the load cycle were considered separately.

For the load cycle, the A_{ij} terms were determined by the expression:

$$A_{ij} = (\varepsilon_{i,1} - 2\varepsilon_{i,2} + \varepsilon_{i,3})/(T_{j,1} - 2T_{j,2} + T_{j,3}) \quad .. \quad [5.23]$$

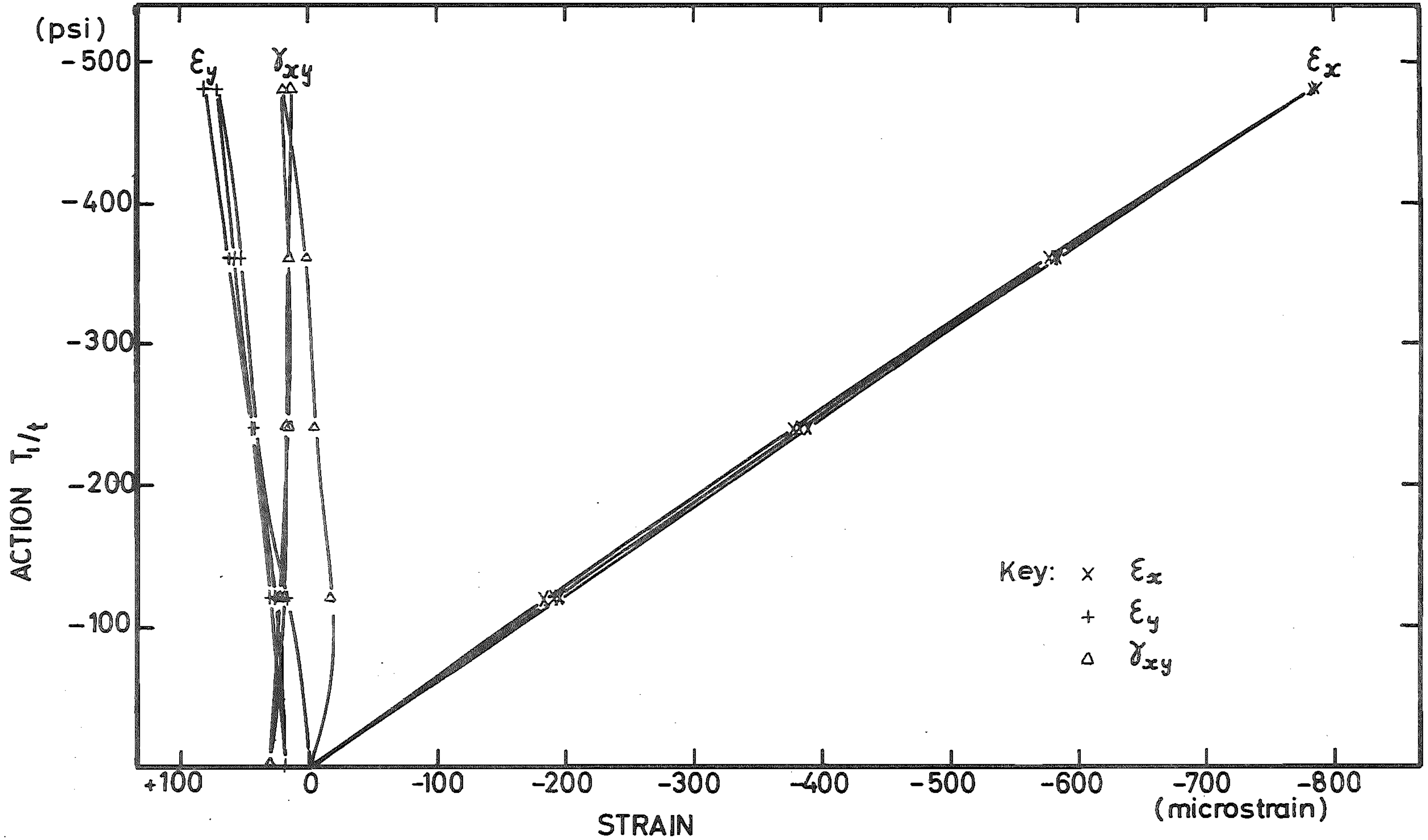


FIG.5.36 Grand average strain-action curve for action T_1 on all prototype elements.
Average grading modulus = $0{\cdot}966 \times 10^6$ psi at 10·7 % m/c.

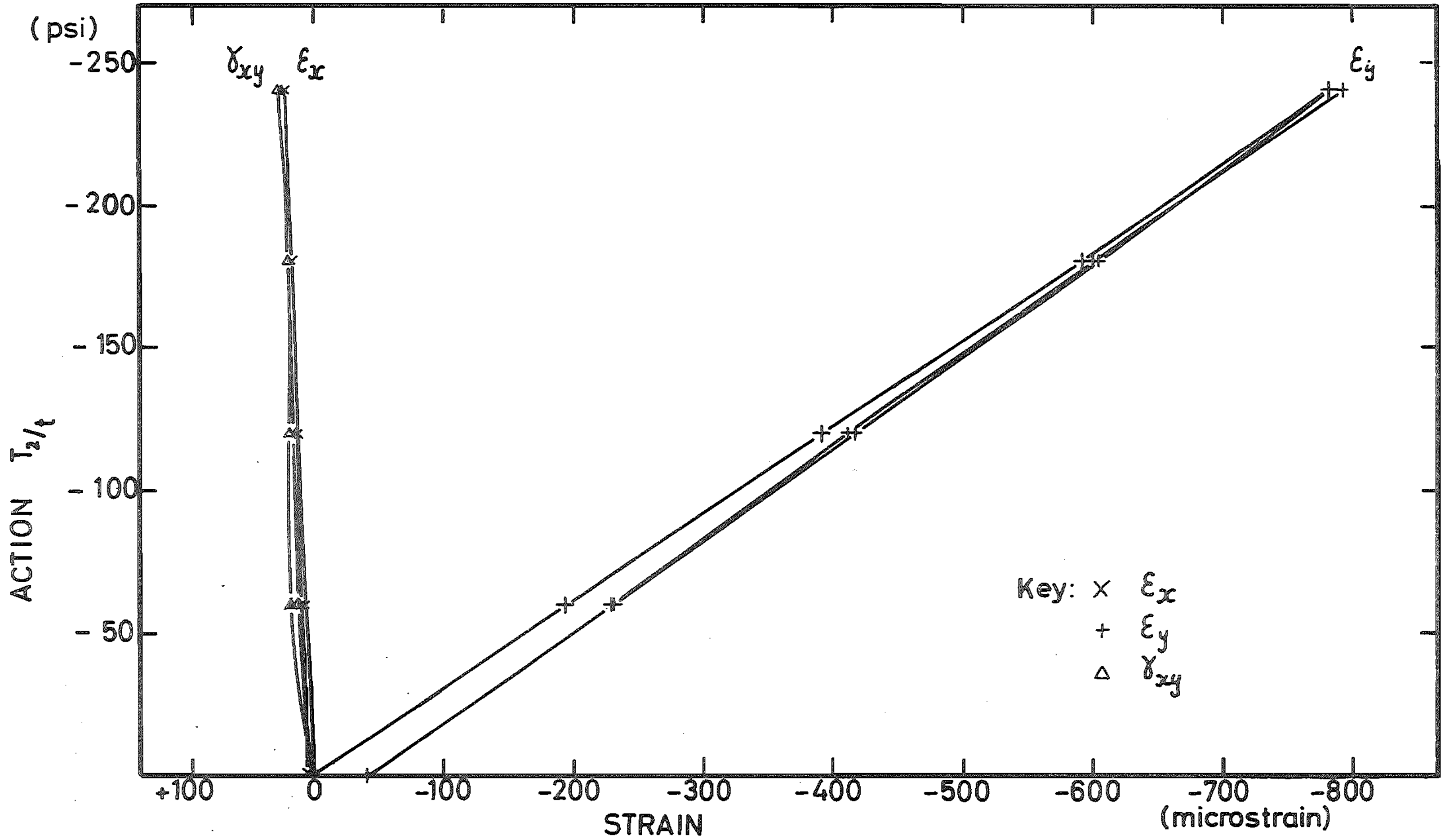


FIG.5.37 Grand average strain-action curve for action T_2 on all prototype elements.
Average grading modulus = $0{\cdot}966 \times 10^6$ psi at 10·7% m/c.

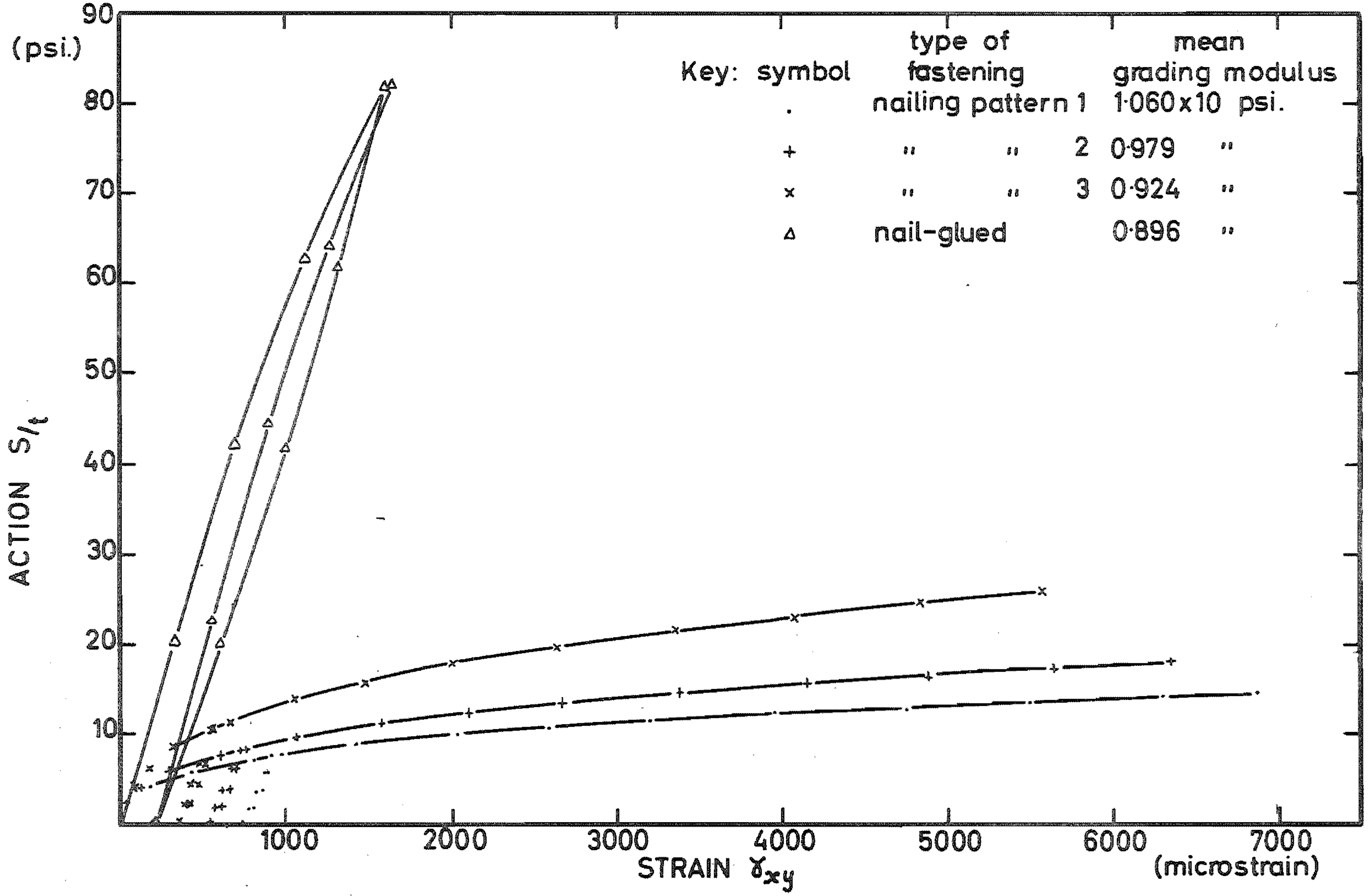


FIG.5.38 Grand average strain-action curve for action S and shear strain γ_{xy} on prototype elements.

where the subscripts 1, 2 and 3 refer respectively to the beginning, minimum and end points of the load cycle and $\mathcal{E}$ and T are the mean strain and action values related by $_i$ and $_j$ respectively. This expression is similar to that used to calculate the mean slope of the load cycle portion of the nailed joint load-slip curves in section 4.4.1. The values obtained are shown plotted against the inverse of grading modulus in figure 5.39.

For behaviour on initial loading, the A_{ij} terms were the slopes of the regression lines fitted to the curves between zero load and the beginning of the load cycle except in the case of the $S - \gamma_{xy}$ curves for the nailed elements where the term A_{33} was not determined but the expression:

$$S = (A\gamma_{xy} + B)(1 - e^{C\gamma_{xy}})^D \quad . \; . \; . \; [5.24] \text{ was fitted.}$$

The values for A_{ij} for initial loading and A, B, C and D from [5.24] are shown in figures 5.40 and 5.41.

Regressions and correlations of A_{ij} against $^1/_E$ were calculated for all four types of fastening as well as for the three nailed types together giving the coefficients in table 5.4. Correlations significant at the 1% level were found for constants A_{11} and A_{22}, both when each type of fastening was considered separately and when they were considered together, indicating no significant difference between each type of fastening. For constants A_{12} and A_{21} the correlations improved with increasing nailing density and were significant at the 1% level for type 3 fastening, for nail-gluing and when they were considered collectively. This indicates that the nailing density has no effect on the deformations due to Poisson ratio effects but rather on the experimental error associated with measuring them.

The correlations for the remaining A_{ij} constants were generally low with values significant at the 5% level being obtained in only two cases for constant A_{31} for elements with pattern 2 on initial loading and for constant A_{13} for elements with pattern 1 on initial loading. The constants A_{13}, A_{23}, A_{31} and A_{32} should have been zero, but, especially for A_{13} and A_{23}, some high values were obtained. A_{33} appears to have no significant correlation with grading modulus.

The regression lines for the three nailed types together and for the nail-glued fastening are shown in figures 5.39 and 5.40.

The values of A, B, C and D and the associated regression statistics are tabulated in table 5.5. None of the regressions was significant, even at the 5% level. Nor does any one coefficient show a better correlation than the others, in contrast to the nailed joint coefficients where coefficients A and B showed the best correlations. This difference may be due however to the small number of elements tested.

Figure 5.41 shows that the type of fastening has a marked effect on the values of coefficients A and B.

TABLE 5.4 REGRESSION OF A_{ij} CONSTANTS AGAINST $^1/_E$ BY THE EQUATION $A_{ij} = M(^1/_E) + C$

TYPE OF FASTENING	ELEMENT LABEL	MODULUS E	MODULUS $^1/_E$	ACTION T_1 LOAD A_{11}	ACTION T_1 CYCLE A_{21}	ACTION T_1 SLOPE A_{31}	ACTION T_1 INITIAL SLOPE A_{11}	ACTION T_1 INITIAL SLOPE A_{21}	ACTION T_1 INITIAL SLOPE A_{31}	ACTION T_2 LOAD A_{12}	ACTION T_2 CYCLE A_{22}	ACTION T_2 SLOPE A_{32}	ACTION T_2 INITIAL SLOPE A_{12}	ACTION T_2 INITIAL SLOPE A_{22}	ACTION T_2 INITIAL SLOPE A_{32}	ACTION S LOAD A_{13}	ACTION S CYCLE A_{23}	ACTION S SLOPE A_{33}	ACTION S INITIAL SLOPE A_{13}	ACTION S INITIAL SLOPE A_{23}	ACTION S INITIAL SLOPE A_{33}
1	A5	1.581	.633	.849	-.058	.261	.862	.094	.179	-.015	1.847	.400	-.028	2.018	.473	-.234	.565	33.37	-.299	2.281	
	51	1.490	.671	.987	-.050	-.180	.988	-.089	-.055	-.038	1.996	-.086	-.083	2.376	-.318	-.020	-.140	17.24	-.410	-.833	
	E5	.986	1.014	1.499	-.164	.030	1.528	-.211	-.207	-.048	2.843	-.095	-.076	3.176	.009	-.515	-.843	27.09	.199	1.917	
	52	.839	1.192	1.498	-.114	.244	1.415	-.171	.281	-.182	3.105	-.121	-.074	4.108	.043	.385	-.374	18.62	1.414	.627	
	15	.724	1.381	1.860	-.082	-.291	1.887	-.121	-.179	-.063	3.980	-.344	-.069	4.232	-.087	-.055	-.418	28.84	.535	.322	
	53	.654	1.529	2.119	-.147	.328	2.226	-.158	.385	-.118	4.428	-.135	-.133	5.108	-.157	.321	.138	39.12	1.864	1.639	
Regression Coefficients			M	1.310	-.078	.068	1.369	-.185	.164	-.106	2.851	-.472	-.062	3.175	-.265	.468	-.444	9.20	2.187	.233	
			$C(X10^{-6})$	+.067	.019	-.007	.020	-.088	-.108	.036	-.034	.442	-.011	.091	.275	-.521	.313	17.53	-1.790	.743	
Correlation coeff.			r	.986**	-.606	.098	.967**	-.628	.242	-.630	.992**	-.704	-.679	.987**	-.362	.509	-.314	.401	.873*	.073	
2	11	1.482	0.675	.998	-.062	-.151	.974	-.100	-.407	-.027	2.003	.092	-.041	2.173	-.063	.140	-.043	16.72	.174	-.308	
	B1	1.257	0.800	1.065	-.040	-.265	1.060	-.073	-.322	-.023	2.163	-.084	-.022	2.146	-.093	-.712	-.597	21.70	-.537	-.939	
	12	0.916	1.092	1.616	-.150	.512	1.598	-.198	.193	-.106	3.053	-.521	-.112	3.357	-.388	.505	-.760	21.69	.369	-.530	
	F1	0.912	1.096	1.567	-.089	.245	1.563	-.115	.105	-.071	3.126	-.126	-.058	3.161	.096	.411	-.574	35.45	.575	-.920	
	J1	0.664	1.506	2.071	-.141	.152	2.083	-.077	.107	-.116	4.256	.626	-.102	4.389	.717	-.379	-.650	26.49	.729	-1.121	
	13	0.643	1.555	2.205	-.113	.338	2.153	-.196	.319	-.091	4.173	-.026	-.104	4.661	.061	-.065	.117	27.66	-.555	-.478	
Regression Coefficients			M	1.382	-.102	.507	1.374	-.060	.713	-.094	2.659	.351	-.085	2.945	.577	-.051	.077	9.87	-.149	-.255	
			$C(X10^{-6})$	.038	.011	-.423	.032	-.059	-.800	.033	.149	-.416	.022	.014	-.592	.041	-.521	13.89	.042	-.430	
Correlation coeff.			r	.994**	-.724	.635	.996**	-.378	.869*	-.845*	.995**	.365	-.804	.990**	.563	-.039	.074	.546	.085	-.285	
3	21	1.450	0.690	1.034	-.081	-.133	1.035	-.108	.017	-.044	2.008	-.037	-.053	2.038	-.137	-.245	-.025	13.13	-.221	.510	
	C2	1.140	0.877	1.274	-.082	-.386	1.286	-.104	-.454	-.018	2.456	-.426	-.051	2.400	0.610	-.256	-.504	28.99	2.627	.509	
	22	0.899	1.112	1.652	-.113	.155	1.626	-.134	.072	-.047	3.077	-.340	-.086	3.115	-.572	.297	-.103	15.24	.611	.796	
	G2	0.844	1.185	1.657	-.115	.004	1.687	-.138	-.009	-.063	3.430	+.031	-.082	3.532	.104	-.022	-1.208	20.64	.616	-.303	
	23	0.615	1.626	2.302	-.220	.065	2.359	-.262	-.067	-.107	4.305	-.314	-.161	4.421	-.361	.411	-.967	18.31	1.026	-1.169	
	E2	0.599	1.669	2.213	-.187	-.129	2.269	-.225	-.247	-.099	4.238	-.207	-.113	4.350	-.370	-.370	-.575	26.12	.135	1.003	
Regression Coefficients			M	1.265	-.139	.185	1.328	-.157	-.022	-.079	2.347	-.070	-.094	2.479	-.032	.235	-.498	4.11	-.343	-.657	
			$C(X10^{-6})$	.179	.033	-.291	.125	+.025	-.088	.032	.452	-.132	.022	.352	-.286	-.312	.075	15.51	1.209	1.009	
Correlation coeff.			r	.993**	-.950**	.382	.996**	-.938**	.044	.909*	.993**	-.152	-.899*	.990*	.047	.289	-.455	.262	-.136	-.317	
1 + 2 + 3 together			M	1.325	-.111	.214	1.366	-.142	.215	-.088	2.590	-.095	-.083	2.787	.019	.216	-.358	6.129	.665	-.347	
			$C(X10^{-6})$	.087	.013	-.195	.048	-.028	-.257	-.028	.211	.011	.012	.267	-.114	-.266	.032	17.33	-.230	.558	
Correlation coeff.			r	.989**	-.769**	.304	.985**	-.643**	.308	-.701**	.989**	-.120	-.800**	.958**	.019	.213	-.284	.298	.278	-.115	
Nail-glued	31	1.423	0.703	.998	-.085	.093	1.008	-.081	.073	-.023	1.875	-.158	-.043	1.799	-.170	-.149	.816	16.03	-.201	.834	17.16
	DG	1.068	0.962	1.290	-.101	-.230	1.297	-.121	-.232	-.055	2.362	-.369	-.059	2.368	-.336	.118	-.570	16.68	.188	-.466	18.20
	32	0.960	1.042	1.440	0.123	.227	1.422	-.139	.193	-.082	2.512	-.231	-.090	2.432	-.268	.313	.491	17.29	.256	.500	19.79
	EG	0.784	1.276	1.579	-.110	.076	1.714	-.133	.069	-.084	3.208	.331	-.105	3.222	.345	.392	-.824	15.73	.461	-.807	18.10
	33	0.651	1.536	2.199	-.191	.499	2.227	-.207	.519	-.193	3.763	.279	-.216	3.738	.231	1.005	.368	20.11	1.176	.430	22.74
	LG	0.490	2.041	2.623	-.228	-.220	2.664	-.275	-.245	-.229	4.153	-.190	-.229	4.723	-.208	-.210	.976	17.51	-.288	1.353	20.11
Regression Coefficients			M	1.259	-.112	-.058	1.293	-.142	.053	-.165	1.798	.161	-.159	2.237	.141	.088	.905	1.59	.095	.624	2.63
			$C(10X^{-6})$	.102	.002	.147	.093	.019	.130	.096	.713	-.259	.076	.229	-.246	.139	-.301	15.23	.146	-.503	16.04
Correlation coeff.			r	.987**	-.950**	-.100	.992**	-.978**	.089	-.962**	.974**	.265	-.943**	.996**	.837	.094	.261	.483	.085	.379	.626
All together			M	1.291	-.114	.082	1.333	-.144	.141	-.119	2.234	.001	-.117	2.459	.063	.215	.015	3.24	.412	.021	
			$C(10X^{-6}$	.110	.012	-.038	.075	-.028	.150	.057	.500	-.86	.041	.439	-.159	-.205	-.244	18.73	-.022	.177	
Correlation coeff.			r	.987**	-.827**	.162	.987**	-.725**	.200	-.800**	.947**	.002	-.830**	.920**	.077	.210	.008	.174	.202	.008	

A_{33} has no meaning for nailed elements on initial loading

* significant at 5% level

** significant at 1% level

TABLE 5.5 Values of A, B, C and D in equation $S = (A\gamma_{xy}+B)(1-e^{C\gamma_{xy}})^D$ and statistics for regression against grading modulus

FASTENING	ELEMENT LABEL	GRADING MODULUS X10^6 psi	A X10^6 lb/in.	B lb/in.	C X10^6	D
1	51	1.490	.002138	28.40	-.001319	.4620
	52	.839	.002187	30.16	-.001659	.5800
	53	.654	.002295	23.15	-.001260	.4913
	A5	1.581	.002427	17.16	-.001197	.4741
	E5	.986	.001441	11.64	-.001229	.4481
	I5	.724	.002047	24.10	-.000885	.4507
Regression statistics		M	.000196	-2.46	-.000041	-.0317
		C(X10^6)	.001884	25.01	-.001215	.5175
		r	.226	-.140	-.066	-.254
2	11	1.482	.004001	31.25	-.001555	.5636
	12	.916	.003281	29.35	-.001305	.4542
	13	.643	.002726	27.07	-.001018	.5259
	B1	1.257	.002757	20.95	-.000744	.5219
	F1	.912	.002978	20.43	-.001002	.3164
	J1	.664	.002978	26.32	-.001546	.5216
Regression statistics		M	.000942	1.70	-.000019	.0685
		C(X10^6)	.002198	24.23	-.001176	.4168
		r	.658	.129	-.020	.255
3	21	1.450	.007216	51.92	-.003334	.9031
	22	.899	.007006	38.38	-.002454	.7447
	23	.615	.005501	36.88	-.001699	.6558
	C2	1.140	.005691	27.34	-.001200	.5509
	G2	.844	.004740	24.26	-.001716	.5127
	K2	.599	.004412	25.26	-.001650	.5967
Regression statistics		M	.002482	19.87	-.001406	.2556
		C(X10^6)	.003466	15.74	-.000710	.4243
		r	.704	.616	-.600	.578

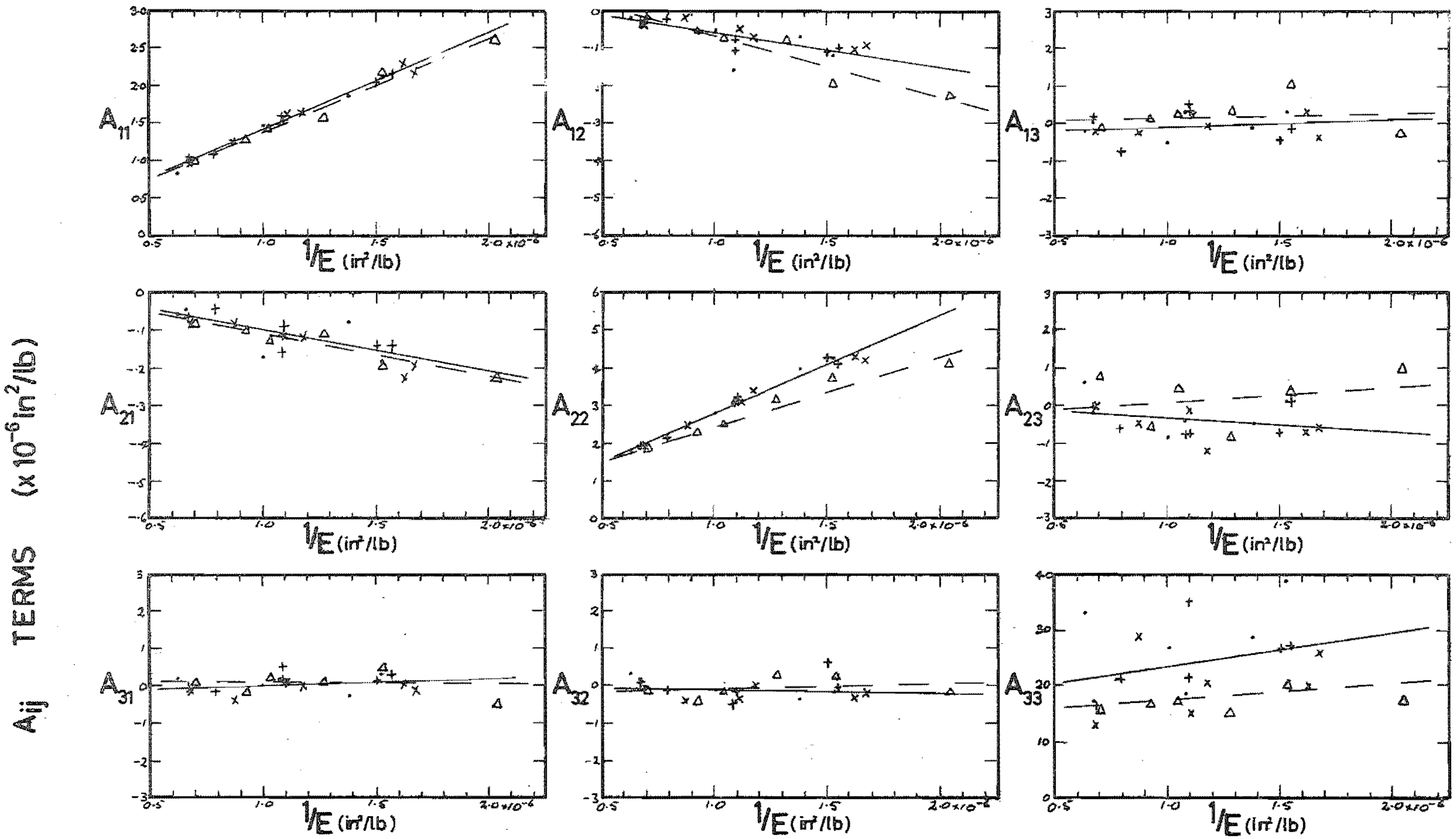


FIG.5.39. Plot of A_{ij} terms against inverse of grading modulus for load cycle behaviour of prototype elements.

KEY Symbol	Fastening		Regression lines
·	1	considered together	————————
+	2		
x	3		
Δ	2 + glue		— — — —

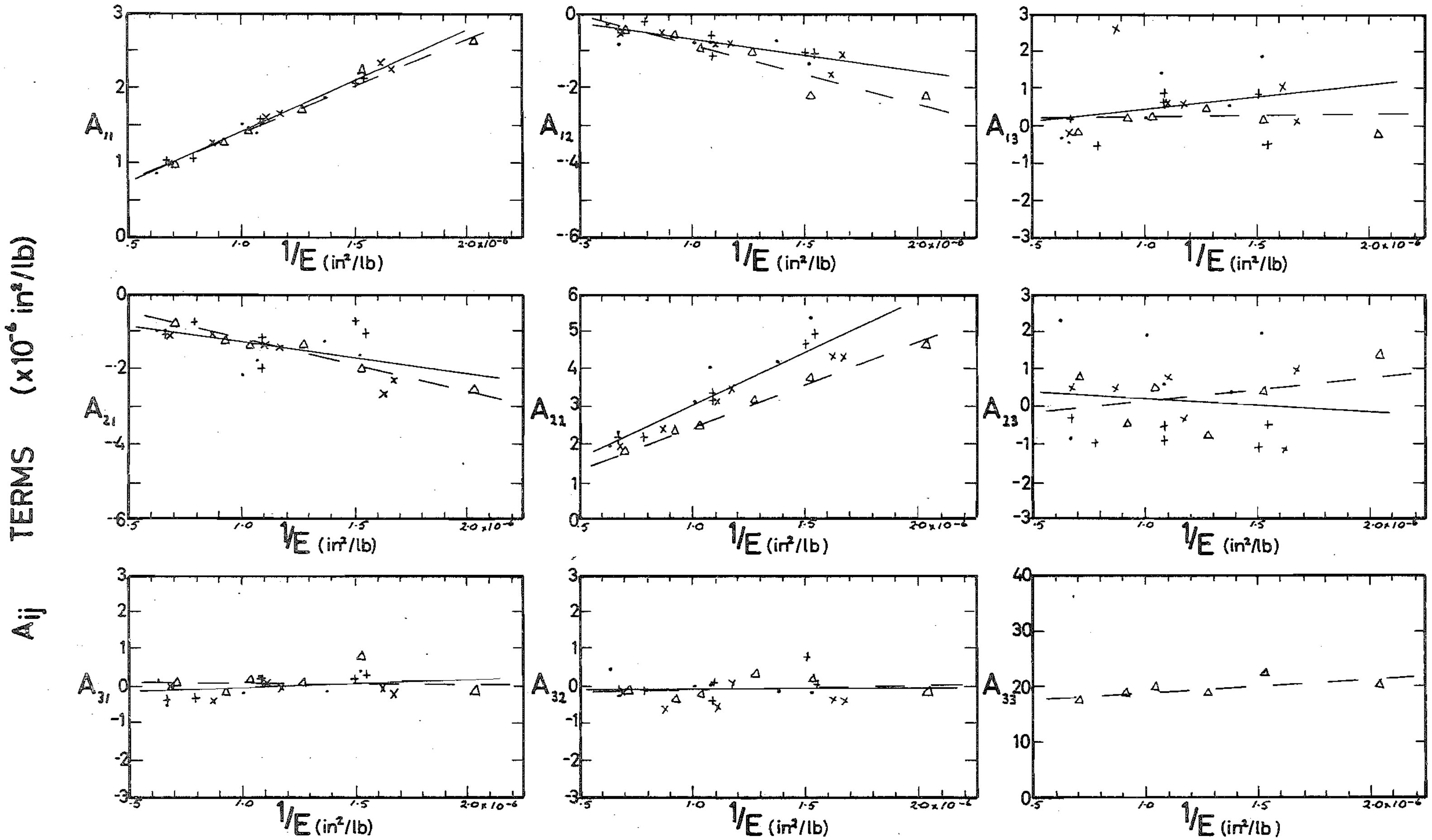


FIG. 5.40. Plot of Aij terms against inverse of grading modulus for initial loading on prototype elements.

KEY	Symbol	Fastening		Regression lines
	·	1	considered together	————————
	+	2		
	×	3		
	Δ	2 + glue		— — — —

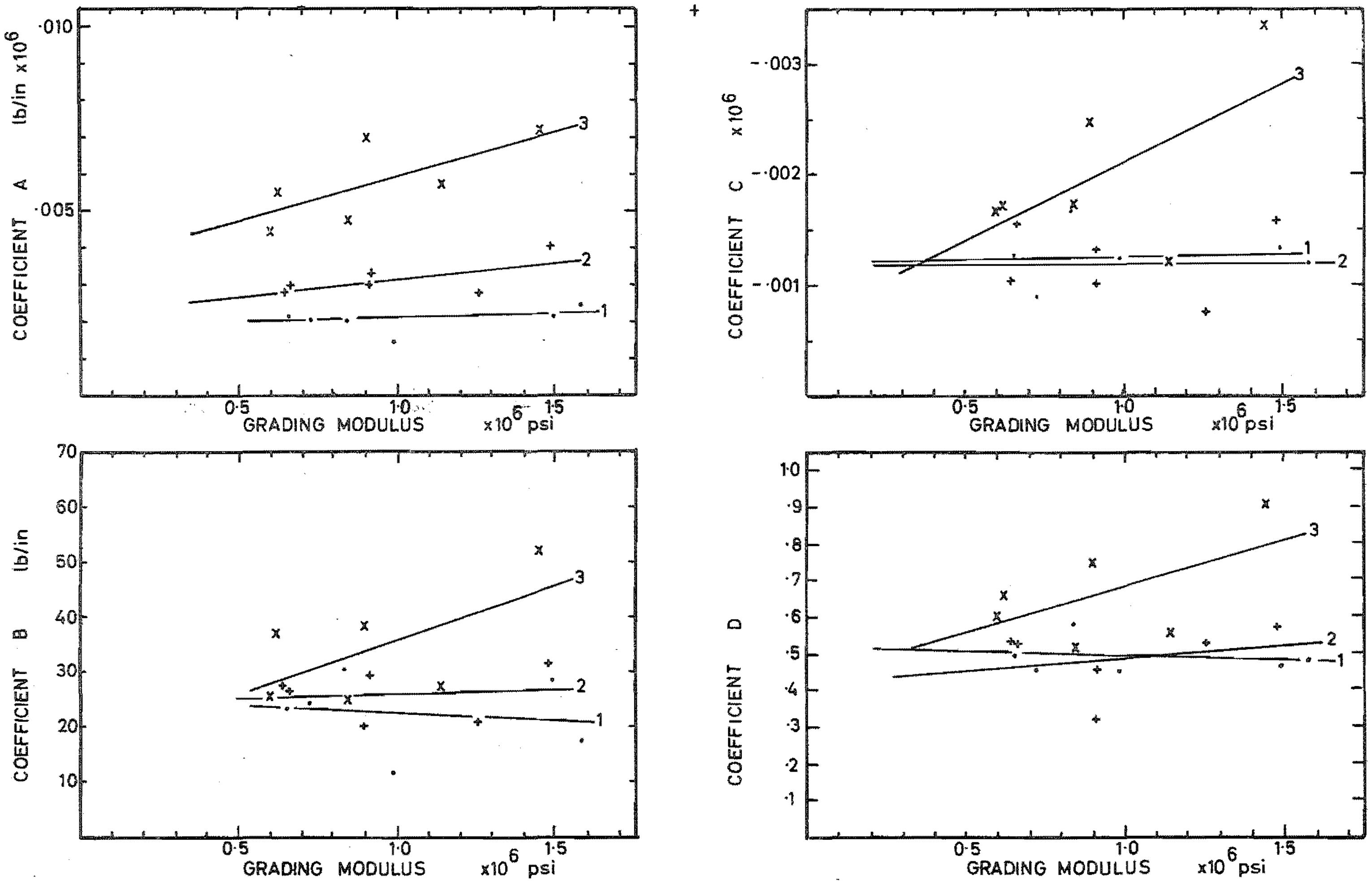


FIG. 5.41 Plot of coefficients A B C and D from the expression $S = (A\gamma_{xy}+B)(1-e^{C\gamma_{xy}})^{D}$ fitted to shear action - strain curves of prototype nailed elements.

KEY Symbol	Fastening	Regression line
·	1	1
+	2	2
x	3	3

5.4.2 Bending and Torsion

5.4.2.1 Data Processing

The curvature of the elements tested under actions M_1 or M_2 were calculated by the expression:

$$\text{curvature } k_x \text{ or } k_y = \frac{\Delta_1 - \Delta_2 + \Delta_3}{144} \quad \ldots\ldots\ldots \quad [5.25]$$

where Δ_1, Δ_2 and Δ_3 are the mean deflections in inches of each pair of targets labelled 1 to 3 in figure 5.29. The calculated values of M_1, M_2, k_x and k_y are contained in table B.4 together with the deflections of each target.

Similarly in the torsion tests, curvature and twist were calculated by expressions [5.26]:

$$k_x = \left[\frac{\Delta_1 + \Delta_7 - 2\Delta_4}{10.5^2} + \frac{\Delta_2 + \Delta_8 - 2\Delta_5}{10.5^2} + \frac{\Delta_3 + \Delta_9 - 2\Delta_6}{10.5^2}\right] / 3$$

$$k_y = \left[\frac{\Delta_1 + \Delta_3 - 2\Delta_2}{10.5^2} + \frac{\Delta_4 + \Delta_6 - 2\Delta_5}{10.5^2} + \frac{\Delta_7 + \Delta_9 - 2\Delta_8}{10.5^2}\right] / 3 \quad [5.26]$$

$$k_{xy} = (\Delta_1 + \Delta_9 - \Delta_3 - \Delta_7) / 21^2$$

where Δ_1 to Δ_9 are the deflections of targets numbered 1 to 9 respectively as shown in figure 5.34. The calculated values of H_1, k_x, k_y and k_{xy} are contained in table B.4 together with the deflections of each target. The grand average action - curvature curves shown in figures 5.42 to 5.44 typify the behaviour observed.

5.4.2.2 Correlation With Grading Modulus

Values for the terms B_{ij} in the expression [5.3] were obtained by considering the load cycle and initial loading separately.

For the load cycle, the B_{ij} terms were determined by [5.27]:

$$B_{ij} = \frac{t^3}{12}(k_{i,1} - 2k_{i,2} + k_{i,3})/(M_{j,1} - 2M_{j,2} + M_{j,3}) \quad \ldots\ldots \quad [5.27]$$

where the subscripts 1, 2 and 3 refer respectively to the beginning, minimum and end points of the load cycle while k and M are the mean curvature and action values related by $_i$ and $_j$ respectively.

Since the elements showed reasonably linear behaviour on initial loading, the value computed for B_{ij} referring to initial loading was the slope of the regression line fitted to the curve up to the beginning of the load cycle. The values obtained are shown plotted against the inverse of grading modulus in figures 5.45 and 5.46 and tabulated in table 5.6. The constants B_{11} gave correlations significant at the 1% level for each type of fastening considered individually. The type of fastening had a marked effect as may be seen in figures 5.45 and 5.46 and as shown by the fact that the correlations were low when the values were correlated collectively.

The constants B_{22}, however, were not affected by the type of fastening and showed significant correlation with grading modulus both individually and collectively.

The constants B_{13} and B_{23} should have been zero but some high values were obtained. These appear to be due to experimental error since the mean values are small.

The constants B_{33} vary with type of fastening rather than grading modulus. The regression lines for each type of fastening are shown separately for B_{11} and B_{33} only, since it was in these cases that significant differences were found.

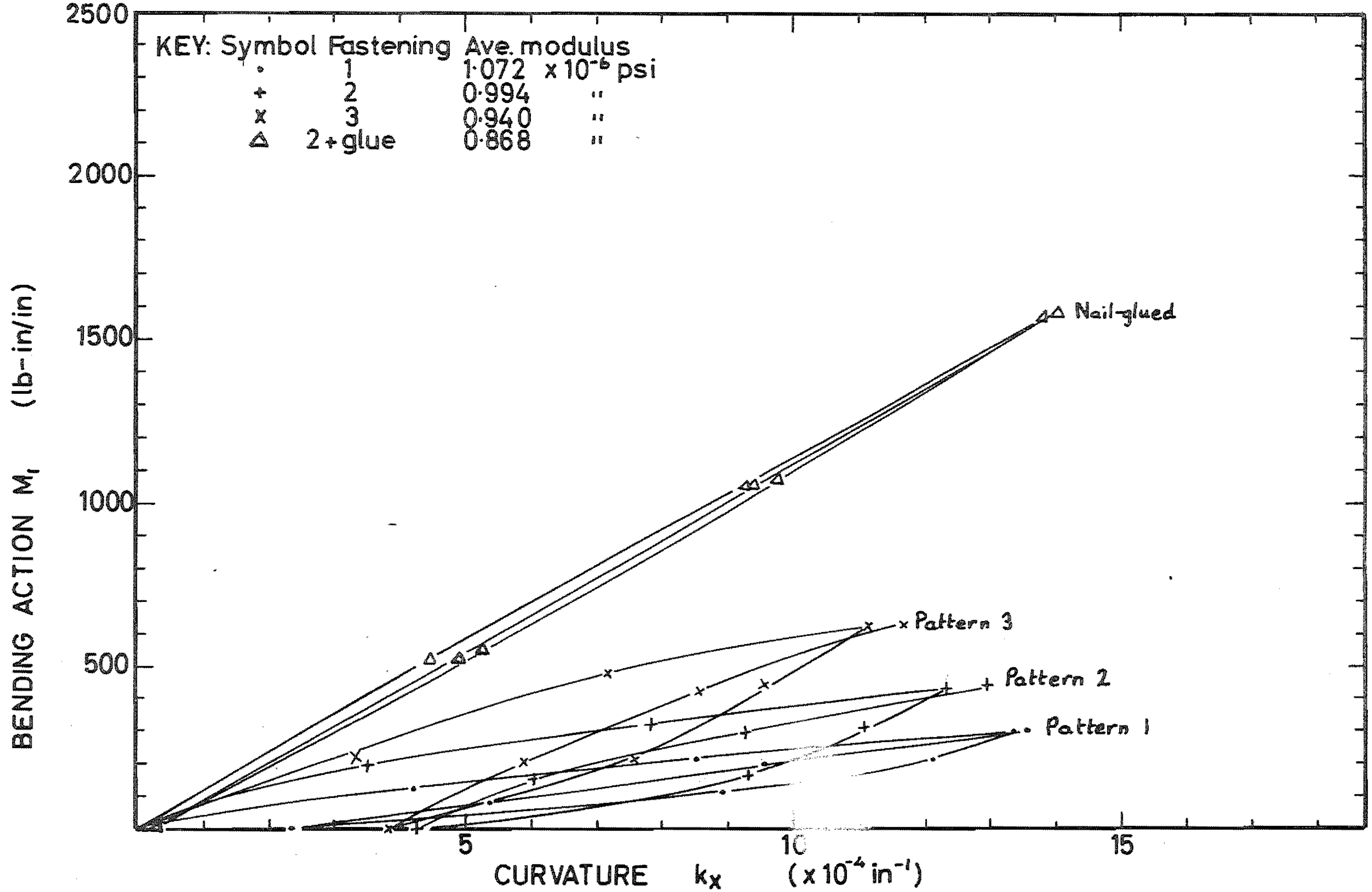


FIG.5.42. Grand average curvature-action curves for action M_1 on prototype elements.

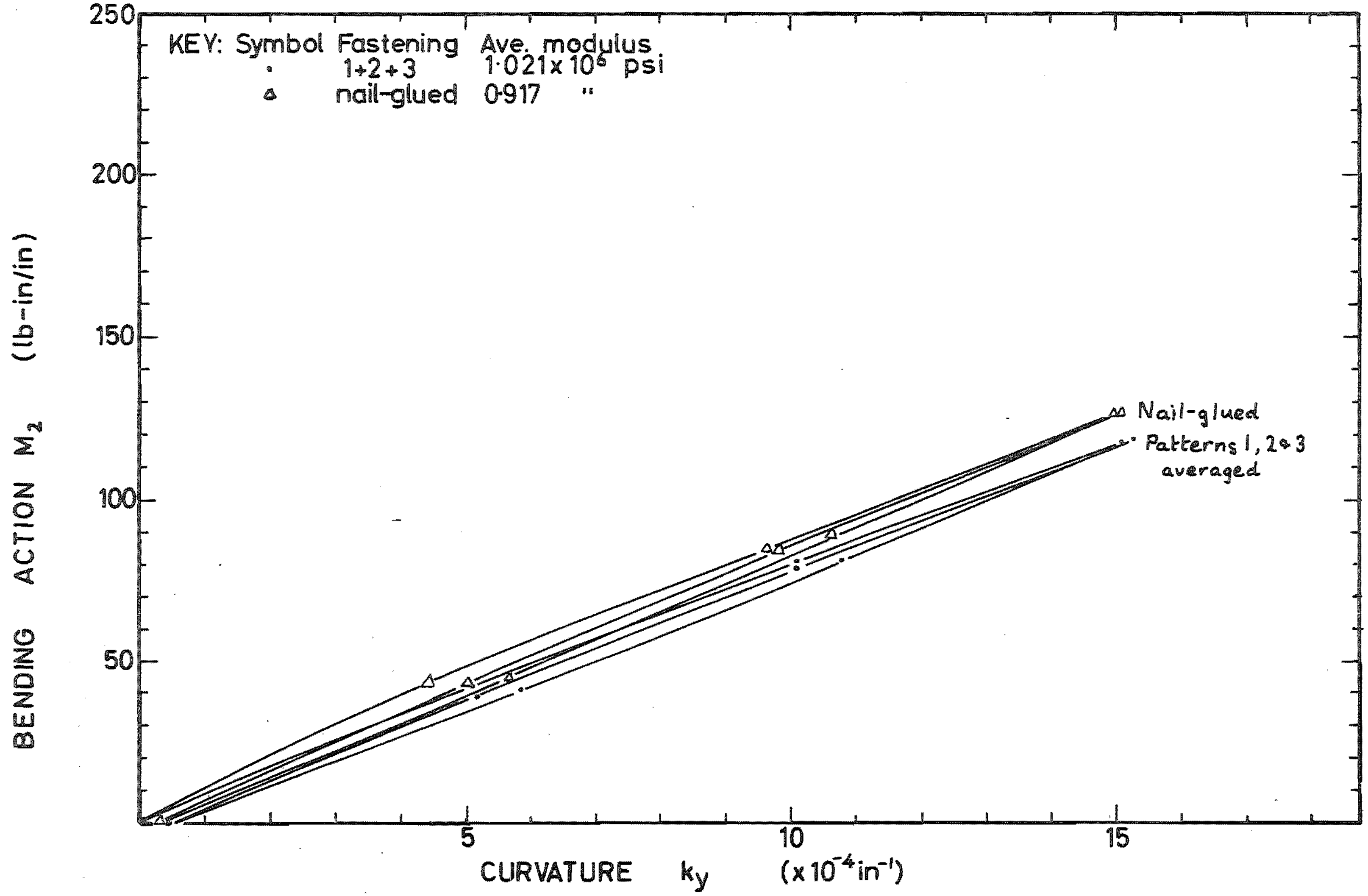


FIG.5.43. Grand average action-curvature curves for action M_2 on prototype elements.

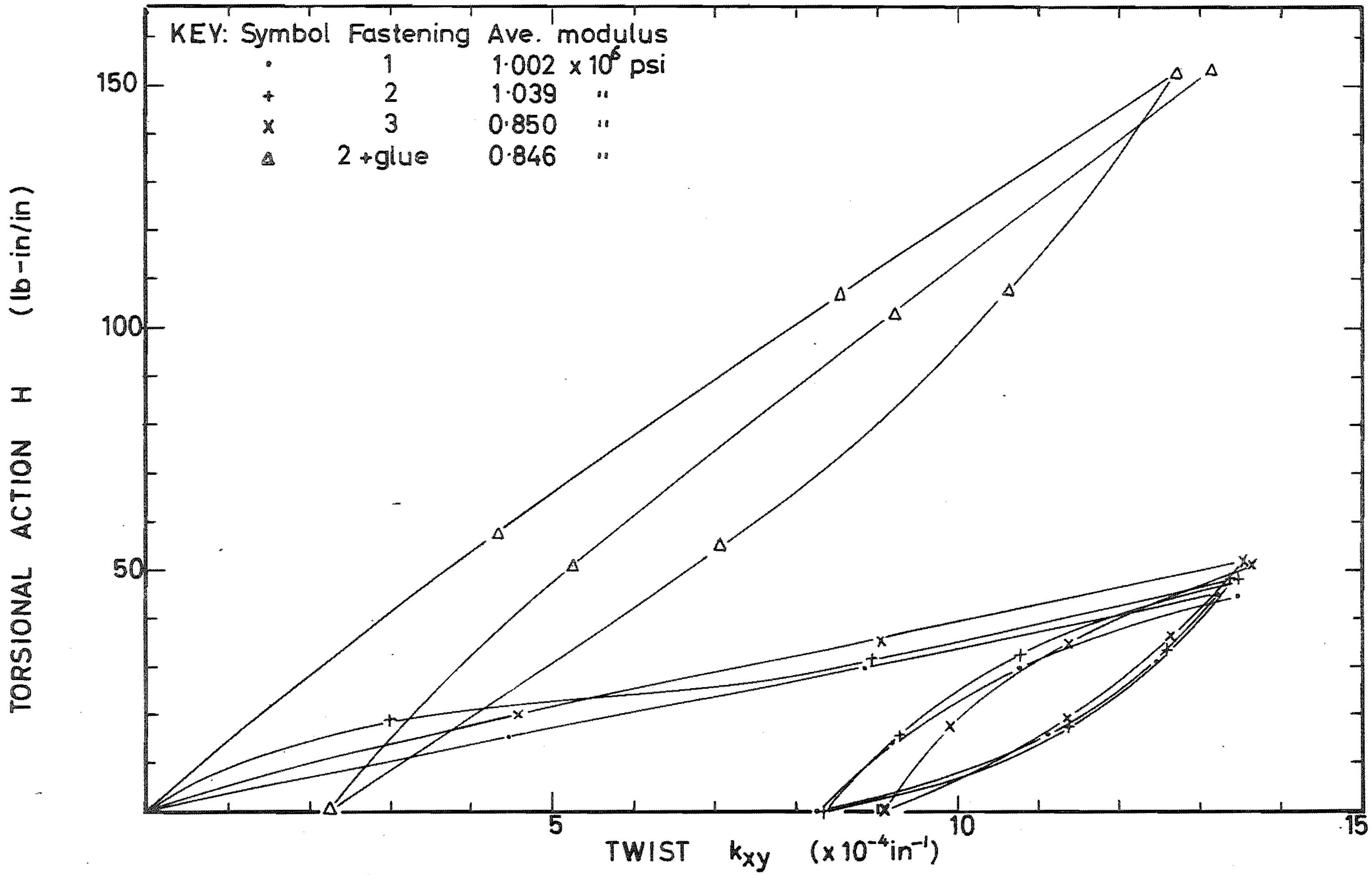


FIG.5.44. Grand average action-twist curves for action H on prototype elements.

TABLE 5.6 REGRESSION OF B_{ij} CONSTANSTS AGAINST $^1/_E$ BY THE EQUATION $B_{ij} = M(^1/_E) + C$

BENDING ACTION M_1

FASTENING	LABEL	GRADING MODULUS E ($X10^6$ psi)	GRADING MODULUS $^1/_E$ ($X10^{-6}$ in.^{2}/lb)	B_{11} LOAD CYCLE ($X10^{-6}$ in.^{2}/lb)	B_{11} INITIAL LOADING ($X10^{-6}$ in.^{2}/lb)
1	X4	.532	1.880	6.534	8.402
	X8	.706	1.416	6.792	6.814
	X12	.876	1.141	5.608	6.495
	X16	1.064	.940	5.078	6.332
	X20	1.417	.706	4.004	4.885
	X24	1.840	.544	2.951	3.906
Regression			M	2.753	3.082
Coefficients			C($X10^{-6}$)	2.121	2.735
Correlation coeff.			r	.910*	.963**
2	X3	.493	2.030	3.129	4.987
	X7	.645	1.550	2.682	4.332
	X11	.820	1.220	2.500	3.878
	X15	1.007	.993	2.521	3.809
	X19	1.308	.765	2.547	3.383
	X23	1.691	.591	1.887	2.595
Regression			M	.714	1.477
Coefficients			C($X10^{-6}$)	1.728	2.072
Correlation coeff.			r	.902*	.964**
3	X2	.471	2.096	2.301	3.065
	X6	.610	1.639	2.083	2.835
	X10	.785	1.275	1.516	2.508
	X14	.972	1.029	1.591	2.470
	X18	1.212	.825	1.307	1.885
	X22	1.591	.629	1.225	1.796
Regression			M	.768	.885
Coefficients			C($X10^{-6}$)	.712	1.320
Correlation coeff.			r	.970**	.956**
1 + 2 + 3			M	.935	1.314
together			C($X10^{-6}$)	2.003	2.580
Correlation coeff.			r	.264	.349
Nail-glued	X1	.384	2.608	2.704	2.639
	X5	.554	1.806	1.622	1.698
	X9	.737	1.357	1.272	1.310
	X13	.942	1.062	1.038	1.031
	X17	1.116	.896	.773	.798
	X21	1.482	.675	.693	.741
Regression			M	1.040	1.009
Coefficients			C($X10^{-6}$)	-.108	-.035
Correlation coeff.			r	.992**	.995**
All			M	.689	.764
together			C($X10^{-6}$)	1.039	2.497
Correlation coeff.			r	.217	.205

BENDING ACTION M_2

FASTENING	LABEL	GRADING MODULUS E ($X10^6$ psi)	GRADING MODULUS $^1/_E$ ($X10^{-6}$ in.^{2}/lb)	B_{22} LOAD CYCLE ($X10^{-6}$ in.^{2}/lb)	B_{22} INITIAL LOADING ($X10^{-6}$ in.^{2}/lb)
1	Y4	.549	1.821	23.10	24.39
	Y8	.711	1.408	24.24	25.33
	Y12	.876	1.141	16.25	16.25
	Y16	1.077	.929	14.96	15.51
	Y20	1.447	.691	12.54	12.70
	Y24	1.949	.513	10.39	10.61
Regression			M	10.934	11.828
Coefficients			C($X10^{-6}$)	5.060	4.645
Correlation coeff.			r	.936**	.935**
2	Y3	.527	1.896	27.73	29.41
	Y7	.680	1.471	24.67	25.39
	Y11	.841	1.189	20,17	21.18
	Y15	1.007	.993	16.86	16.91
	Y19	1.299	.770	14.35	14.16
	Y23	1.609	.622	11.84	12.02
Regression			M	12.854	14.180
Coefficients			C($X10^{-6}$)	4.400	3.441
Correlation coeff.			r	.990**	.993**
3	Y2	.527	1.869	24.02	24.51
	Y6	.654	1.529	18.76	20.57
	Y10	.789	1.267	15.89	16.99
	Y14	.976	1.024	16.35	16.05
	Y18	1.212	.825	14.15	14.57
	Y22	1.582	.632	10.34	10.00
Regression			M	9.625	10.682
Coefficients			C($X10^{-6}$)	5.122	4.393
Correlation coeff.			r	.962**	.981**
1 + 2 + 3			M	11.068	12.144
together			C($X10^{-6}$)	4.929	4.250
Correlation coeff.			r	.929**	.992**
Nail-glued	Y1	.445	2.249	17.89	18.50
	Y5	.575	1.738	19.82	20.60
	Y9	.981	1.020	15.13	15.20
	Y13	.911	1.098	15.42	15.23
	Y17	1.099	.910	13.88	13.98
	Y21	1.491	.671	11.43	12.21
Regression			M	4.258	4.515
Coefficients			C($X10^{-6}$)	10.140	10.170
Correlation coeff.			r	.854*	.872*
All			M	8.348	9.107
together			C($X10^{-6}$)	7.255	6.865
Correlation coeff.			r	.821**	.869*

TORSIONAL ACTION H

FASTENING	LABEL	GRADING MODULUS E ($X10^6$ psi)	GRADING MODULUS $^1/_E$ ($X10^{-6}$ in.^{2}/lb)	LOAD CYCLE B_{13}	LOAD CYCLE B_{23}	LOAD CYCLE B_{33}	INITIAL LOADING B_{13}	INITIAL LOADING B_{23}	INITIAL LOADING B_{33}
				$X10^{-6}$ in.^{2}/lb			$X10^{-6}$ in.^{2}/lb		
1	T1	1.348	.742	.004	.696	11.36	-.095	.218	36.93
	T5	1.067	.938	-1.141	-.860	17.70	-.477	-.132	34.92
	T9	.875	1.143	-.558	-.807	14.40	.315	-1.380	39.91
	T13	.719	1.390	-.530	1.318	15.66	-.265	.840	42.8
Regression			M	-.424	1.096	4.275	-.102	.459	10.689
Coefficients			C($X10^{-6}$)	-.109	-1.068	10.277	-.238	-.597	17.381
Correlation coeff.			r	.252	.278	.447	.084	.136	.861
2	T2	1.272	.786	-.008	.040	14.50	.140	-.823	37.58
	T6	1.014	.986	-.520	.716	13.70	-.781	-.807	38.19
	T10	.832	1.202	-.594	.934	13.06	-.214	-.185	36.25
Regression			M	-1.394	2.134	-3.455	-.805	1.551	-3.274
Coefficients			C($X10^{-6}$)	1.008	-1.552	17.178	.513	-2.143	40.586
Correlation coeff.			r	.909	.952	.996*	.360	.887	.687
3	T3	1.182	.846	-.897	.067	11.87	-.585	.107	31.34
	T7	.951	1.051	.506	.354	10.72	.339	-.418	32.05
	T11	.796	1.257	-.437	-.123	9.41	-.946	-.658	32.09
	T14	.684	1.463	1.579	-2.021	9.88	.456	-1.845	38.02
	T15	.636	1.573	2.506	2.976	14.15	1.791	1.397	37.69
Regression			M	4.103	1.273	1.377	2.417	.218	9.98
Coefficients			C($X10^{-6}$)	-4.428	-1.324	9.502	-2.782	-.553	21.882
Correlation coeff.			r	.866	.211	.216	.673	.055	.892*
1 + 2 + 3			M	2.356	1.005	-.807	1.329	.489	4.304
together			C($X10^{-6}$)	-2.634	-.846	13.928	-1.508	-.852	31.683
Correlation coeff.			r	.598*	.218	.088	.494	.147	.342
Nail-glued	T4	1.128	.887	-.231	-.765	8.89	.036	-.670	10.36
	T8	.915	1.093	.138	-.470	9.03	.632	-.604	10.91
	T12	.759	1.318	.170	.158	9.30	.315	-.227	10.89
	T16	.584	1.712	.425	1.211	9.04	.551	1.182	11.41
Regression			M	.718	2.461	.196	.427	2.322	1.147
Coefficients			C($X10^{-6}$)	-.774	-3.048	8.819	-.151	-2.986	9.456
Correlation coeff.			r	.939	.994**	.405	.563	.950*	.945
All			M	1.797	1.443	-1.788	1.132	1.097	5.389
together			C($X10^{-6}$)	-2.039	-1.452	14.096	-1.225	-1.511	36.276
Correlation coeff.			r	.559*	.362	.186	.492	.364	.131

* significant at 5% level

** significant at 1% level

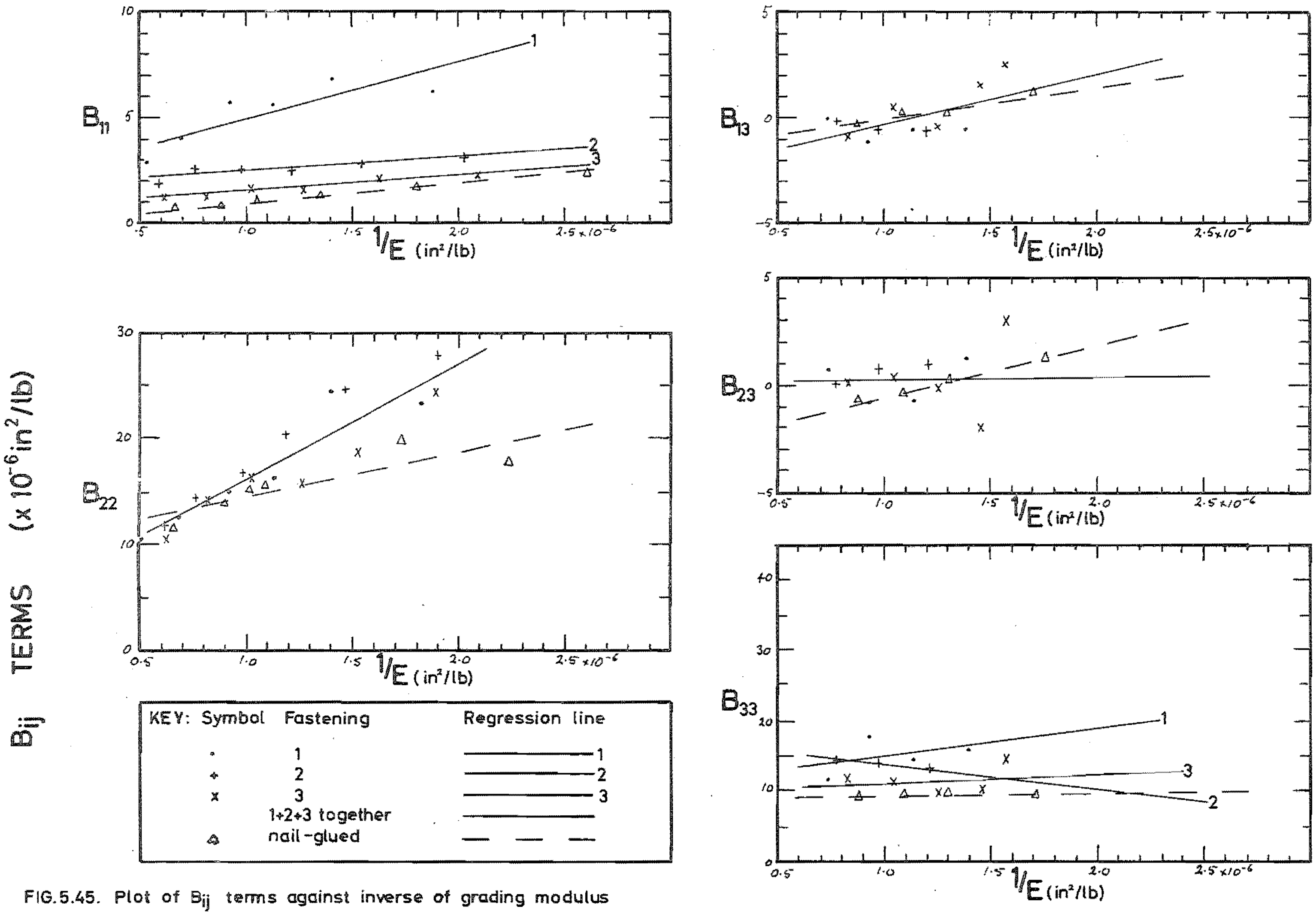


FIG.5.45. Plot of B_{ij} terms against inverse of grading modulus for load cycle behaviour of prototype elements.

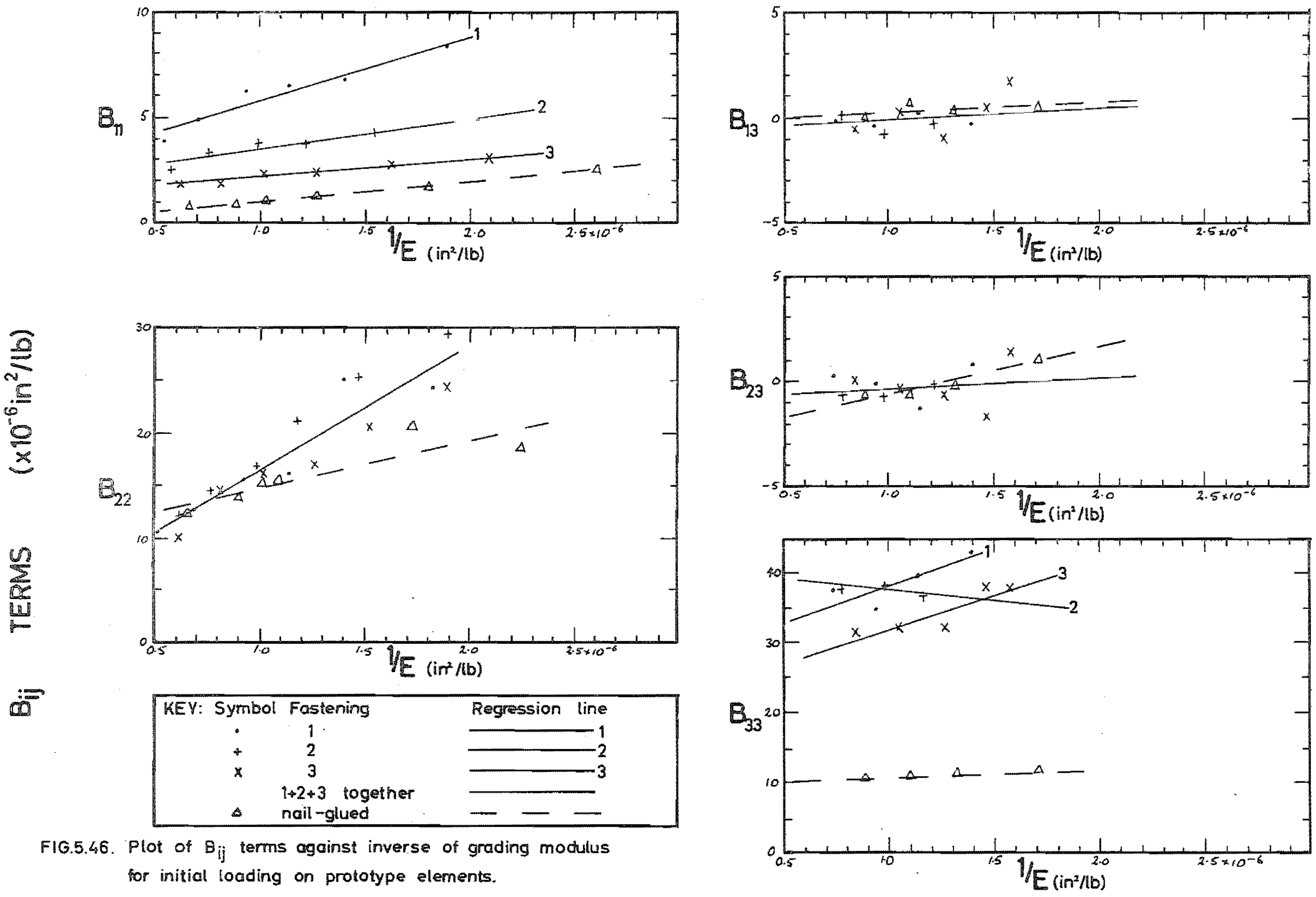


FIG.5.46. Plot of B_{ij} terms against inverse of grading modulus for initial loading on prototype elements.

5.5 COMPARISON WITH THEORY

The mean value of grading modulus used in computing theoretical values of A_{ij} and B_{ij} in section 5.2 was 1.077×10^6 psi. If this value is substituted into the regression equations tabulated in tables 5.4 and 5.6, the values in table 5.7 are obtained. In table 5.7 the influence of type of fastening on the constants can be more clearly seen than in figures 5.39, 5.40, 5.45 and 5.46.

The values of A_{11} and A_{22} agree closely with theory with the nail-glued elements as expected, giving values slightly lower than the others. A_{11}, however, shows higher values for increasing nailing density, a tendency opposite to that expected.

The values of A_{12} agree well with theory, both for nailed and nail-glued elements. The values of A_{21} are lower than expected for the nailed elements. This indicates that the outer layers of boards were restrained from lateral extension from Poisson ratio effects, either by the middle layer or by the load distribution beams of the testing rig. For the nail-glued element the A_{21} values are higher than the A_{12} values and higher than the theoretical value whereas the A_{12} values were lower than the theoretical value. This indicates that either some slip occurred between the layers, contrary to an assumption made in the derivation of the theoretical values of A_{ij} or that the mean of the strains measured at opposite points on the two faces did not represent the mean strain through the element at that point.

TABLE 5.7 Values of A_{ij} and B_{ij} for prototype elements with a mean grading modulus of 1.077×10^6 psi at 10.7% moisture content

TYPE OF FASTENING:			
1	2	3	NAIL-GLUED
$A_{ij} \times 10^{-6}$ in.^{2}/lb - LOAD CYCLE			
$\begin{bmatrix} 1.283 & -.062 & -.086 \\ -.053 & 2.613 & -.099 \\ .056 & .004 & 26.07 \end{bmatrix}$	$\begin{bmatrix} 1.321 & -.052 & -.006 \\ -.084 & 2.618 & -.450 \\ .048 & -.090 & 23.05 \end{bmatrix}$	$\begin{bmatrix} 1.354 & -.041 & -.094 \\ -.096 & 2.631 & -.387 \\ -.119 & -.197 & 19.33 \end{bmatrix}$	$\begin{bmatrix} 1.271 & -.057 & .216 \\ -.102 & 2.382 & .075 \\ .093 & -.110 & 16.71 \end{bmatrix}$
$A_{ij} \times 10^{-6}$ in.^{2}/lb - INITIAL LOADING			
$\begin{bmatrix} 1.291 & -.069 & .241 \\ -.260 & 3.039 & .959 \\ .044 & .029 & ** \end{bmatrix}$	$\begin{bmatrix} 1.308 & -.057 & .180 \\ -.115 & 2.748 & -.667 \\ -.138 & -.056 & ** \end{bmatrix}$	$\begin{bmatrix} 1.358 & -.065 & .891 \\ -.121 & 2.654 & .399 \\ -.108 & -.316 & ** \end{bmatrix}$	$\begin{bmatrix} 1.294 & -.072 & .234 \\ -.113 & 2.306 & .076 \\ .179 & -.115 & 18.48 \end{bmatrix}$
$A_{ij} \times 10^{-6}$ in.^{2}/lb - THEORETICAL			
$\begin{bmatrix} 1.33 & -.064 & \cdot \\ -.591 & 2.45 & \cdot \\ \cdot & \cdot & 624^{*} \end{bmatrix}$	$\begin{bmatrix} 1.33 & -.064 & \cdot \\ -.591 & 2.45 & \cdot \\ \cdot & \cdot & 312^{*} \end{bmatrix}$	$\begin{bmatrix} 1.33 & -.064 & \cdot \\ -.591 & 2.45 & \cdot \\ \cdot & \cdot & 156^{*} \end{bmatrix}$	$\begin{bmatrix} 1.314 & -.092 & \cdot \\ -.092 & 2.424 & \cdot \\ \cdot & \cdot & 11.10 \end{bmatrix}$
$B_{ij} \times 10^{-6}$ in.^{2}/lb - LOAD CYCLE			
$\begin{bmatrix} 4.677 & \cdot & -.503 \\ \cdot & 15.21 & -.050 \\ \cdot & \cdot & 14.25 \end{bmatrix}$	$\begin{bmatrix} 2.391 & \cdot & -.286 \\ \cdot & 16.34 & .429 \\ \cdot & \cdot & 13.97 \end{bmatrix}$	$\begin{bmatrix} 1.425 & \cdot & -.618 \\ \cdot & 14.06 & -.143 \\ \cdot & \cdot & 10.78 \end{bmatrix}$	$\begin{bmatrix} .858 & \cdot & -.107 \\ \cdot & 14.09 & -.763 \\ \cdot & \cdot & 9.00 \end{bmatrix}$
$B_{ij} \times 10^{-6}$ in.^{2}/lb - INITIAL LOADING			
$\begin{bmatrix} 5.597 & \cdot & -.333 \\ \cdot & 15.63 & -.171 \\ \cdot & \cdot & 37.31 \end{bmatrix}$	$\begin{bmatrix} 3.443 & \cdot & -.234 \\ \cdot & 16.61 & -.702 \\ \cdot & \cdot & 37.55 \end{bmatrix}$	$\begin{bmatrix} 2.142 & \cdot & -.538 \\ \cdot & 14.31 & -.351 \\ \cdot & \cdot & 31.15 \end{bmatrix}$	$\begin{bmatrix} .896 & \cdot & .245 \\ \cdot & 14.36 & -.832 \\ \cdot & \cdot & 10.52 \end{bmatrix}$
$B_{ij} \times 10^{-6}$ in.^{2}/lb - THEORETICAL			
$\begin{bmatrix} 0.942 & \cdot & \cdot \\ \cdot & 9.828 & \cdot \\ \cdot & \cdot & 57.68 \end{bmatrix}$	$\begin{bmatrix} 0.942 & \cdot & \cdot \\ \cdot & 9.828 & \cdot \\ \cdot & \cdot & 57.68 \end{bmatrix}$	$\begin{bmatrix} 0.942 & \cdot & \cdot \\ \cdot & 9.828 & \cdot \\ \cdot & \cdot & 57.68 \end{bmatrix}$	$\begin{bmatrix} 0.938 & -2.26 & \cdot \\ -.264 & 9.788 & \cdot \\ \cdot & \cdot & 11.10 \end{bmatrix}$

* values refer to load cycle behaviour only

** A_{33} has no meaning for nailed elements on initial loading

The values for A_{33} for nail-glued elements are higher than predicted indicating that they were more flexible than expected. This is possibly explained by the fact that the layers are constructed of boards rather than a continuous wooden lamina as in the case of plywood. If this is the reason, then an increase in shear stiffness would be gained by edge-gluing the boards during construction of the membrane.

The theoretical values for A_{33} for nailed elements on load cycling are obviously wrong, indicating either that friction transmits most of the load between the layers or that the elements behave in a manner different to that assumed in section 5.2.4. The elements show an increasing stiffness with increasing nailing density, but not in proportion to the number of nails per unit area but rather in proportion to the square root of this number. Also, it is noticed, that for load cycling a stiffness approaching that of a nail-glued membrane may be obtained if sufficient nails are used. However, the non-linear behaviour and low stiffness on initial loading of a nailed membrane would preclude its use in most cases. The increase in stiffness with nailing density shown in figure 5.38 indicates that the stiffness of the nail-glued elements could be equalled at a high but probably impracticable nailing density.

The values for A_{13}, A_{23}, A_{31} and A_{32} are not small in comparison with A_{12} and A_{21}, whereas they should theoretically be zero. If the A_{ij} constants are used to evaluate the state of plane stress causing a set of observed strains ε_x, ε_y and γ_{xy}, then the matrix $[\bar{C}_{ij}]$ is calculated which is the inverse of $[A_{ij}]$. Also, if the anomalous constants A_{13}, A_{31}, A_{23}, A_{32} are assumed zero then a different $[C_{ij}]$ matrix is obtained. The values of C_{ij} for load cycling are compared in table 5.8.

TABLE 5.8 Values of C_{ij} for prototype elements under load cycling including and excluding the anomalous A_{ij} constants

TYPE OF FASTENING			
1	2	3	NAIL-GLUED
C_{ij} X 10^6 psi including anomalous constants			
$\begin{bmatrix} .780 & .019 & .004 \\ .016 & .383 & .002 \\ -.002 & .000 & .038 \end{bmatrix}$	$\begin{bmatrix} .758 & .015 & .001 \\ .024 & .383 & .008 \\ -.002 & .002 & .043 \end{bmatrix}$	$\begin{bmatrix} .740 & .012 & .004 \\ .028 & .381 & .008 \\ .005 & .004 & .052 \end{bmatrix}$	$\begin{bmatrix} .789 & .018 & -.010 \\ .034 & .421 & -.002 \\ -.004 & .003 & .060 \end{bmatrix}$
C_{ij} X 10^6 psi excluding anomalous constants			
$\begin{bmatrix} .780 & .019 & . \\ .016 & .383 & . \\ . & . & .038 \end{bmatrix}$	$\begin{bmatrix} .758 & .015 & . \\ .024 & .383 & . \\ . & . & .043 \end{bmatrix}$	$\begin{bmatrix} .739 & .012 & . \\ .027 & .381 & . \\ . & . & .051 \end{bmatrix}$	$\begin{bmatrix} .788 & .019 & . \\ .039 & .421 & . \\ . & . & .060 \end{bmatrix}$

From table 5.8 it is seen that the anomalous A_{ij} constants have negligible effect on the major C_{ij} constants. This result is similar to a conclusion reached by Walker[32] in his work with electrical resistance strain gauges on solid wood. He found that if the plane on which the state of stress is to be evaluated is approximately parallel to an orthotropic plane then the natural variability of wood is insufficient to require the use of the more general elastic relationships which are applicable to any plane regardless of the orientation of the orthotropic planes. Considering also the low correlations with grading modulus obtained for the anomalous A_{ij} constants, it may be concluded that they may be ignored and that they imply that some error will be involved in the experimental determination of local stresses but little error in calculating overall patterns of stress in a membrane.

Considering the nailed elements in shear, values for A, B, C and

D may be calculated from the regression equations in table 5.5 for a grading modulus of 1.077 X 10^6 psi. In table 5.9 these values are compared with theoretical values as derived from equation [5.15].

TABLE 5.9 Comparison of theoretical and experimental values of coefficients A, B, C and D in expression for shear action - shear strain behaviour of nailed elements at a mean grading modulus of 1.077 X 10^6 psi

TYPE OF FASTENING	THEORETICAL				EXPERIMENTAL			
	A X10^6lb/in.	B lb/in.	C X10^6	D	A X10^6lb/in.	B lb/in.	C X10^6	D
1	.000028	24.8	-.000023	.8511	.002095	22.4	-.001259	.4836
2	.000056	49.5	-.000023	.8511	.003213	26.1	-.001196	.4906
3	.000113	99.0	-.000023	.8511	.006139	37.1	-.002224	.6996

It can be seen from the relative values of A and C in table 5.9 that the elements were from 60 to 100 times stiffer than the theory indicated, and, from the relative values of B, that the stiffness did not show an increase in direct proportion to the nailing density. This demonstrates that the theory is inadequate for describing the behaviour of nailed elements in shear. In contrast to the load cycling behaviour it does not appear that stiffness comparable to that of the nail-glued elements could be obtained by sufficiently increasing the nailing density except, perhaps, for low loads where friction appears to transmit most of the stress. For higher stresses an arrangement containing boards at an angle other than at 90° to the longitudinal direction would be required if nails were the means of fastening.

The value of B_{11} is seen to be dependent on the type of fastening as well as repeated loading. Nail-glued elements were stiffer than theory indicated by 5 to 9%. The stiffness of the elements under action M_1 bears a close linear relationship to the nailing density shown in figure 5.47. This relationship indicates that stiffnesses equivalent to those of the nail-glued elements should be obtained at nailing densities of about 40 and 63 nails/sq ft for load cycling and initial loading respectively. The intercepts of the regression lines at zero are close to a value of $1/B_{11}$ equal to $.0855 \times 10^6$ which may be calculated for the two outer layers acting independently.

The behaviour under action M_2 shows no significant effect of type of fastening or repeated loading. The theoretical values of B_{22} were calculated assuming an outer layer was able to carry tension perpendicular to the board direction as in plywood. This is obviously not possible and, ignoring this layer a value of B_{22} equal to 15.5×10^{-6} in.^{2}/lb is calculated which is close to the observed values.

In torsion the elements were stiffer than expected for all types of fastening. The theoretical stiffness of the nailed elements represents a lower bound as each layer is assumed to act independently while the theoretical stiffness of the nail-glued elements represents an upper bound since a rigid connection between the layers is assumed.
Figure 5.47 shows that the stiffness of the nailed elements in torsion as given by $1/B_{33}$, does not bear as close a linear relationship to nailing density as does $1/B_{11}$. However it appears that equivalent stiffness to the nail-glued elements would be obtained at a nailing density of 37.5 nails/sq ft for load cycling while for initial loading a nail spacing of $\frac{1}{4}$ inch in each direction would be required, which is impracticable.

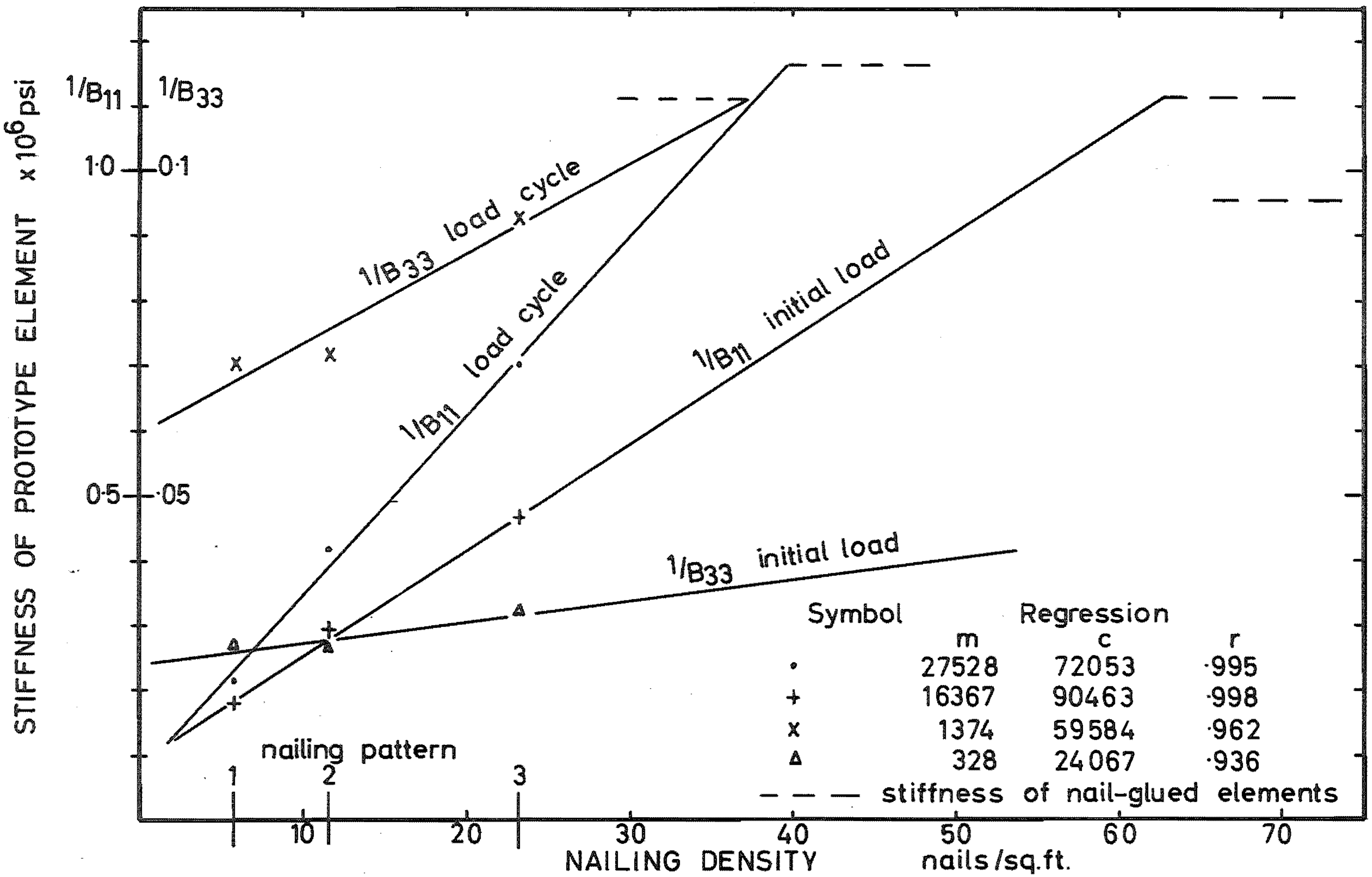


FIG.5.47. Showing the effect of nailing density on the stiffness of prototype elements under actions M_1 and H.

CHAPTER SIX

MODEL SHELL ELEMENTS

6.1 GENERAL

The work described in the previous chapter was repeated on 1/5 scale model elements.

6.2 EXPERIMENTAL INVESTIGATION

6.2.1 Element Preparation

Model boards were machined from prototype boards as described in section 2.3 and their grading modulus measured at 4 in. intervals. From these, 12 in., 8 in., and 1.4 in. lengths were selected according to grading modulus to make up the four types of element shown in figures 5.8 and 5.9. These covered the three nailing patterns and nail-gluing as summarised in table C.1 in the appendix.

The elements were assembled on the jig shown in figure 6.1 which consisted of a $\frac{3}{4}$ in. thick machined steel plate fixed to the top of a 3 ft pillar with a system of pulleys, cables, hangers and $1\frac{1}{4}$ X $\frac{7}{8}$ in. steel distribution beams to apply cramping pressures to the layers of boards. The steel plate was overlaid by a $\frac{1}{4}$ in. thick sheet of expanded polystyrene to allow the points of the model nails to project through the elements. These points were later removed by passing the elements under a grindstone held in the chuck of a drillpress. An 8 in. square nail-glued element for testing in compression and shear is being assembled in figures 6.1 and 6.2.

The template shown in figure 6.2 was used to align the boards at right angles, to draw a guide lines for the nailing pattern and later to locate the holes for the shear rig. A similar but larger template was

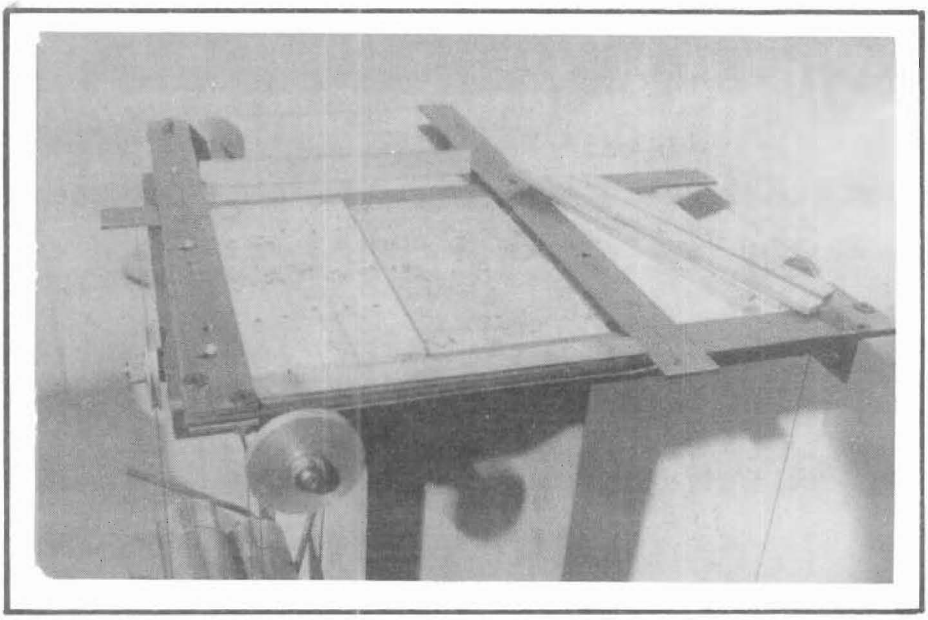


FIG.6.1. Jig used for assembly of all model elements.

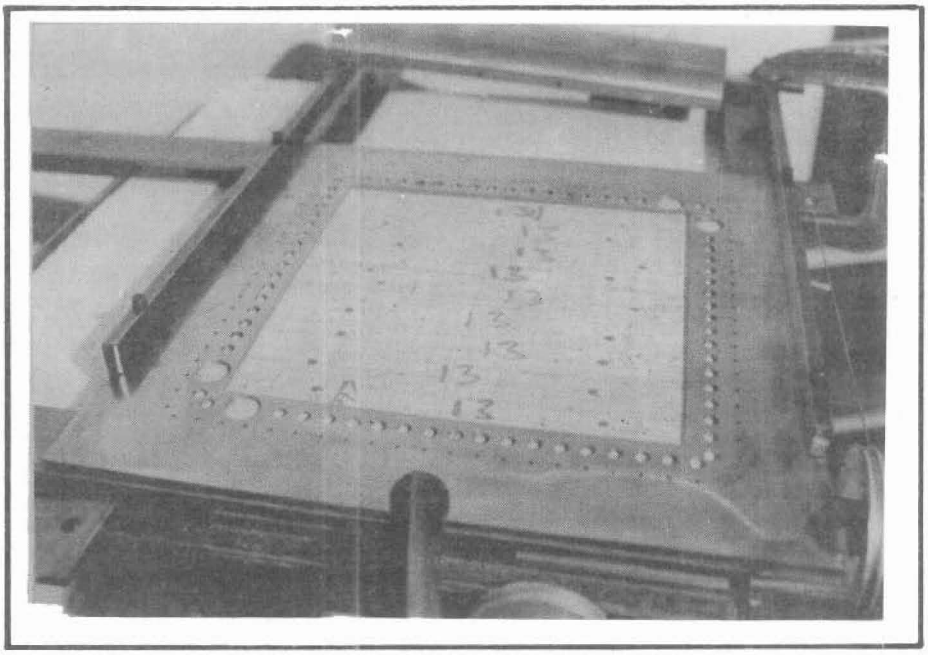


FIG.6.2. 8 in. square element completed showing template for positioning nails and holes for shear apparatus.

used for the torsion and bending elements. Weights were placed on the hangers to produce a cramping force of 4 lb/in. on each layer which was maintained until the element was completed. The amount of glue in the prototype elements was 0.1 lb/sq ft/glueline and therefore to obtain gluelines 1/5 of the prototype glueline thickness, a rate of glue application of 0.02 lb/sq ft/glueline was required in the model elements. However, this rate was too small to give complete coverage so a rate of 0.03 lb/sq ft/glueline was actually used. It was not expected that this would significantly affect the behaviour of the model glued elements since the glue should give a rigid connection regardless of the glueline thickness.

To trim the elements square a circular sawbench with a planer blade was used. Except for the work involving machinery, the assembly of these elements was carried out in the constant temperature room where the atmosphere was controlled to 68 $\pm 2^{\circ}$F and 61 $\pm 2\%$ r.h. These conditions produced an equilibrium moisture content of 10.9%.

6.2.2 Testing

6.2.2.1 Compression - Action T_1 and T_2

The rig in figure 6.3 was constructed to apply actions T_1 or T_2 to elements 7.7 in. square. A steel frame carried a hydraulic ram in its lower member. This ram acted on a 2 X 1 in. distribution beam which could pivot about a horizontal axis in the plane of the element. A hardened steel bar with a Vee-groove in its upper face carried $\frac{1}{4}$ in. diam. steel balls. One inch sections of a similar steel bar were placed on top of the balls to transfer load to the bottom edge of the element. This arrangement ensured axial loading and freedom from lateral restraint. A similar arrangement was used at the top edge but with a 1 in. length of

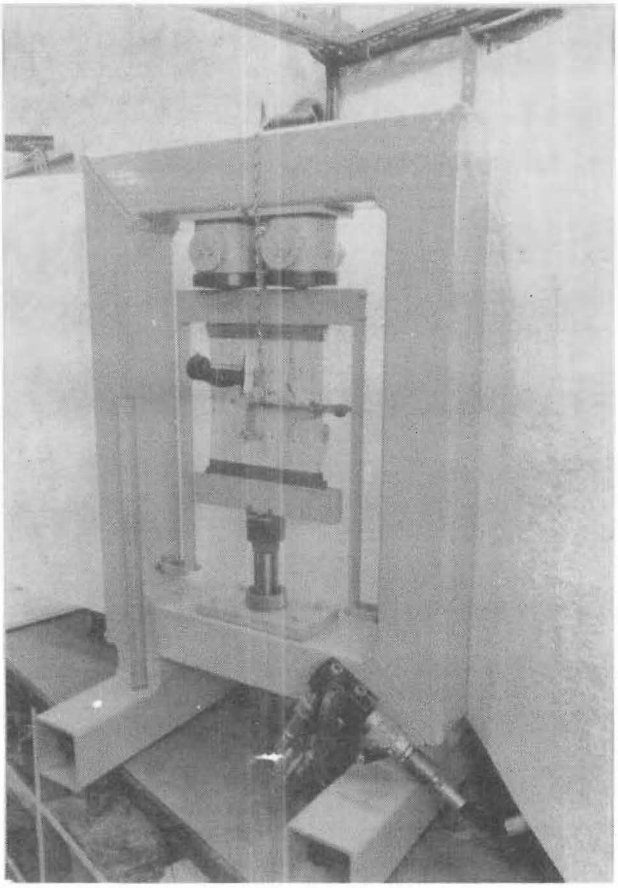


FIG.6.3. Model element being tested under action T_1 with Huggenberger extensometers attached.

$\frac{1}{4}$ in. diam. bar replacing four balls at the centre to prevent the element rolling bodily sideways. A distribution beam at the top was constrained to move vertically by two long arms pivoted at their farther ends. Two 2-ton capacity load cells were connected to a Budd strain indicator to measure the load transferred from the upper distribution beam to the frame to an accuracy of ± 4 lb. A Rheile oil pressure machine connected to the ram was remotely controlled from within the constant temperature room.

Strains were measured on both sides of the elements with a pair of extensometers as shown in figure 6.3. These were set at a gauge length of 4.2 in. and placed successively in positions x_1 and x_2, x_3 and x_4, etc. up to x_9 and x_{10}, and in positions y_5 and y_6 shown in figure 6.4 in successive tests under action T_1. Similarly the gauges were placed in positions y_1 and y_2 up to y_9 and y_{10} and x_5 and x_6 in successive tests under action T_2.

By using a gauge length of 4.2 in. the effect of movement between adjacent boards was automatically allowed for since 4.2 in. was an integral multiple of the board width of 0.7 in. The knife edge contact points of the extensometers rested in grooves scribed on 3/16 in. square steel pieces glued to the element.

The loading procedure followed was similar to those for the prototype elements except that increments of 1/6 maximum load were applied at 2 minute intervals as shown in figure 6.5. The same maximum values of 480 psi for T_1/t and 240 psi for T_2/t as for the prototype elements were used in the model tests. The rate of loading, however, as shown in figure 6.5 was five times the prototype rate. This alteration of procedure was considered admissable from preliminary tests which showed

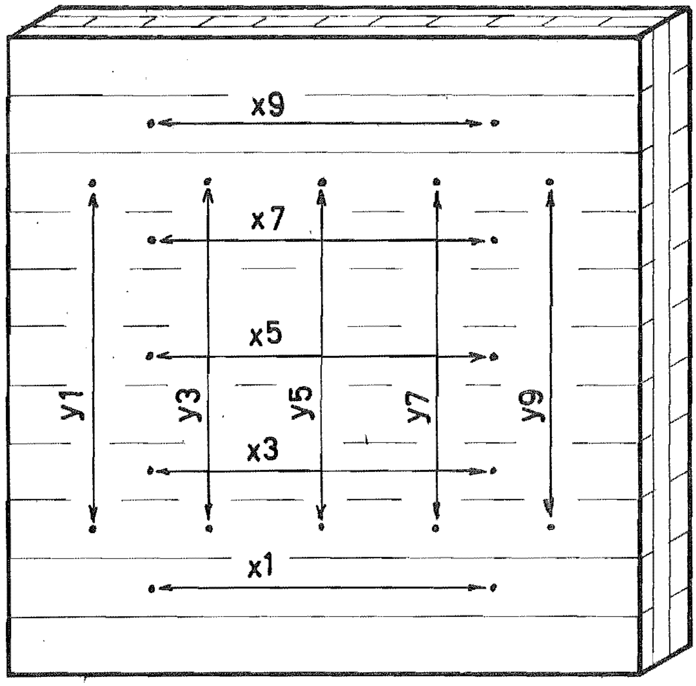


FIG.6.4. Positions of strain measurement on model elements tested under actions T_1 and T_2. Even numbered positions occur on the nail point side directly opposite each preceeding odd numbered position.

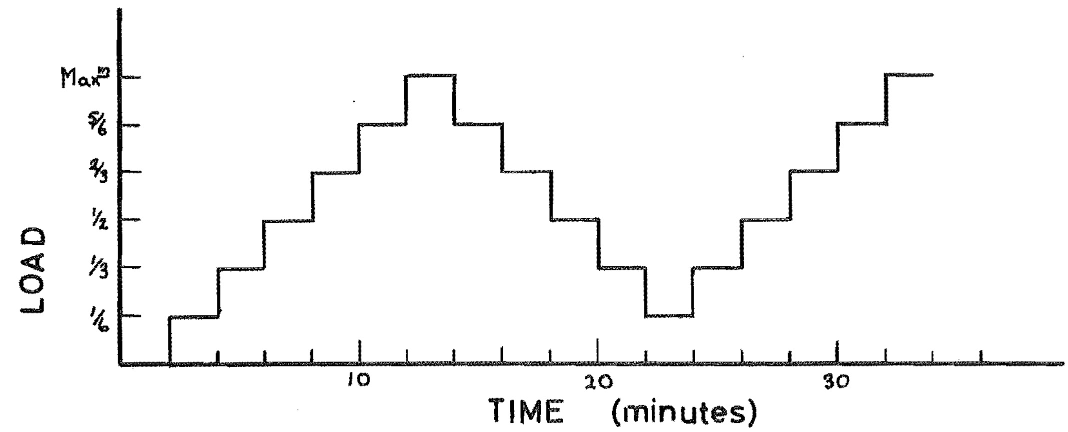


FIG.6.5. Load-time schedule for model elements under T_1 and T_2

that the creep strain occurring in the inverval between 1 and 20 minutes after load application was less than could be detected by the Huggenberger extensometers which were accurate to ± 2 microstrain.

6.2.2.2 Shear - Action S

The rig constructed to apply action S to model elements is shown in figure 6.6. This was essentially the same as the prototype rig except that load was applied by means of weights through a lever system. The counterbalance for this lever is shown in figure 6.6 and also the facility for adjusting the height of the pivot so that the lever could be kept level.

Load was applied to the element through Vee blocks and the bearings, axles, straps, bolts and rubber bushes which are shown in figure 6.7. This arrangement differed from the prototype in that axles were placed at two corners only instead of all four.

Strains were measured on the tension diagonal only by means of two 4 in. gauge length demountable mechanical gauges which were held in place by clips and (suspended on) springs as shown in figure 6.6. The apparatus was too delicate to allow the gauges to be held in position manually and therefore the strain along the compression diagonal could not be measured but was assumed equal and opposite to the strain measured.

The loading procedures shown in figure 6.8 were similar to those for the prototype elements except that more increments were possible with the simpler instrumentation. As in the prototype elements, the load P was calculated to produce 1000 microstrain in shear.

6.2.2.3 Bending - Actions M_1 and M_2

The rig in figure 6.9 was used to apply action M_1 or M_2 to model elements 1.4 in. wide by means of four-point bending over a 11.6 in. span with the load points 6 in. apart.

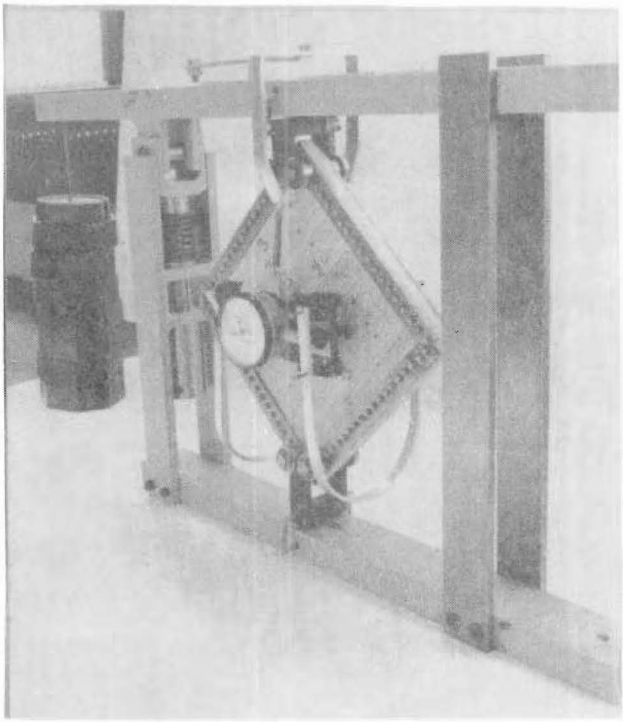


FIG. 6.6. Apparatus for testing model elements under action S.

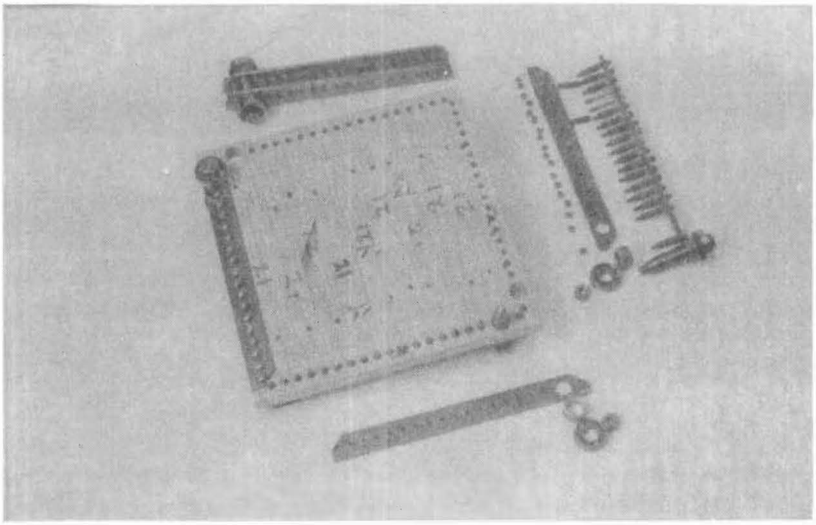


FIG.6.7. Showing assembly of shear apparatus onto model element.

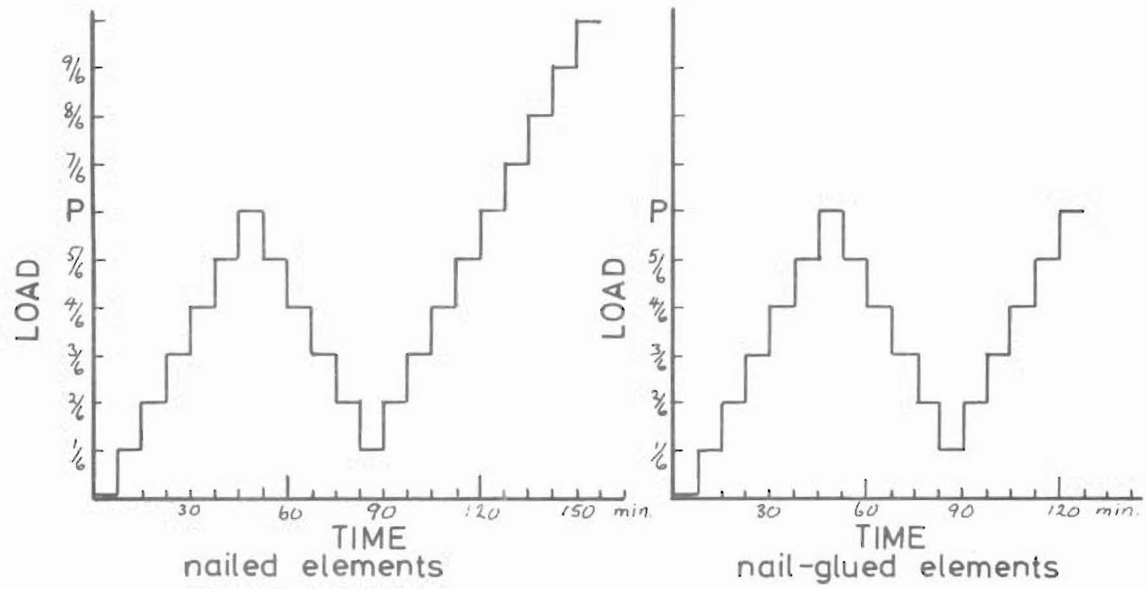


FIG.6.8. Loading schedules for model elements in shear.

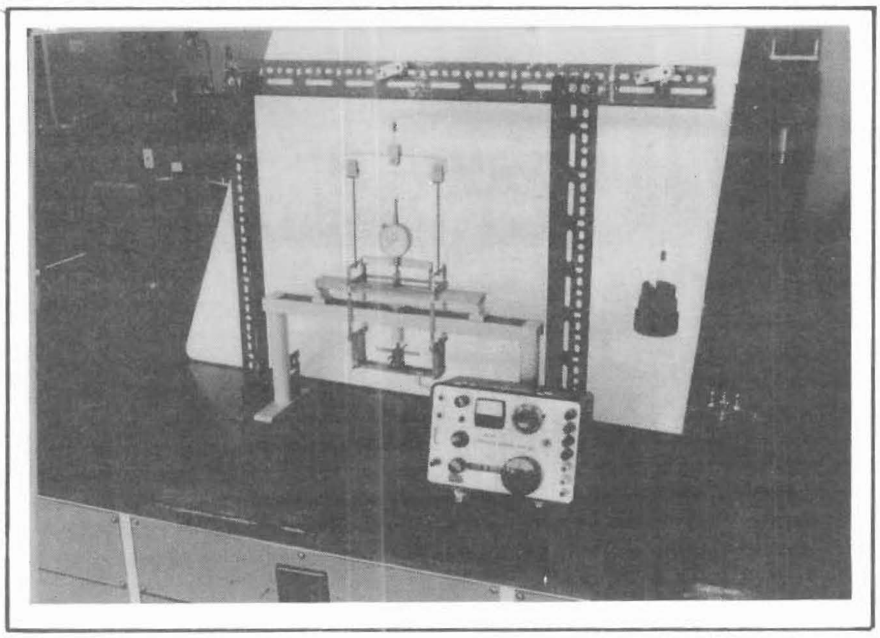


FIG.6.9. Apparatus for applying action M_1 or M_2 to model elements.

It consisted of a beam on two pillars fixed to the laboratory bench. The supports were knife edges, one of which could move towards the other on rollers. The knife edges rested in grooves in $1/16 \times \frac{1}{4} \times 1.4$ in. mild steel strips glued to the element. The loading arrangement consisted of a screw acting vertically beneath the centre of the beam through a thrust bearing onto a distribution beam. This applied load at two points, $\frac{3}{8}$ in. either side of the centre of a $1 \times \frac{1}{4}$ in. mild steel flat bar which was strain gauged at its centre to act as a load cell. Two flat-wound wire grid $\frac{7}{8}$ in. gauge length gauges were placed on both faces of the flat bar and wired to form a four-arm bridge. This load cell enabled loads up to 150 lb to be measured to an accuracy of ± 0.1 lb. Hangers transferred the load from the flat bar to two $\frac{1}{4}$ in. diam. bars which applied the load to the element. A counterbalance lifted the loading system clear of the element when the screw was retracted.

Curvature was measured by means of a dial gauge carried on a yoke which rested on the element at two points 4.8 in. apart. The dial gauge plunger carried a short beam oriented at right angles to the yoke. This short beam rested on the element at two points to provide a self-supporting system. A second dial gauge with a remote sensing lever observed the deflection of the midspan point of the element relative to the bench. The first six load increments each produced deflections of 0.02 in. as observed by this second dial gauge. Thereafter increments of 1/6 of this maximum load were applied at five minute intervals according to figure 6.10.

6.2.2.4 Torsion - Action H

The rig used to apply torsion to elements trimmed 11.8 in. square is shown in figure 6.11. It was essentially the same equipment as was used for the model bending tests. Triangular steel plates $\frac{7}{8}$ in. thick were

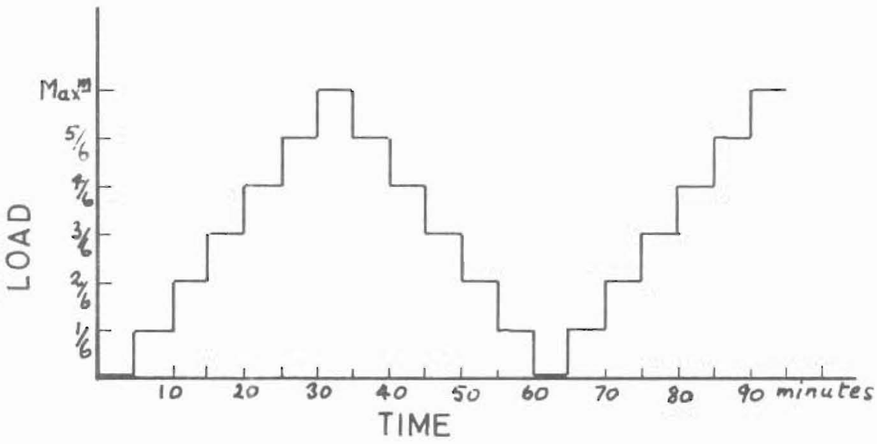


FIG.6.10. Load - time schedule for model elements in bending.

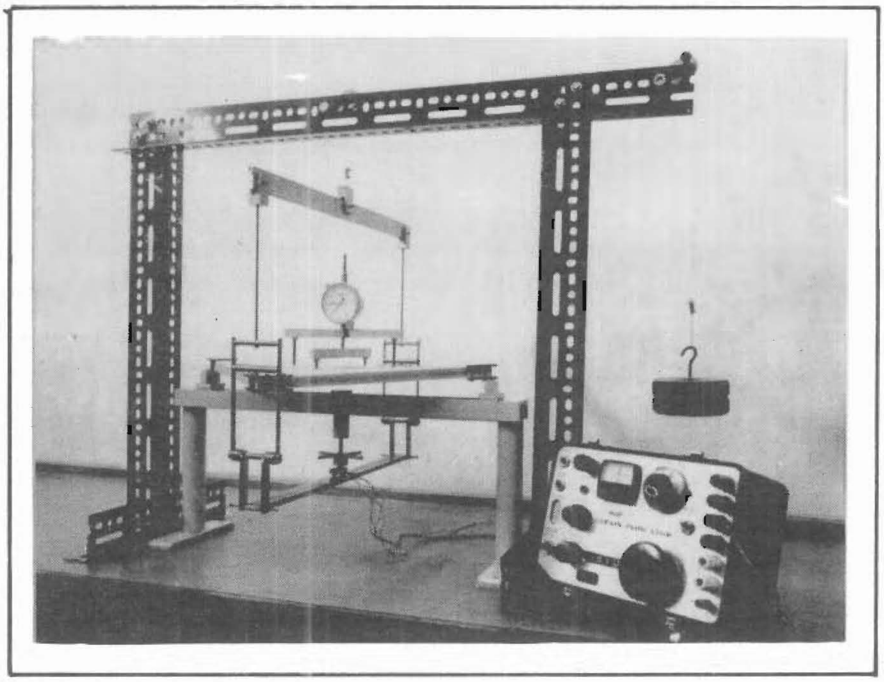


FIG.6.11. Apparatus for testing model elements under action H.

bolted to each corner. Two of these rested on knife edge supports while load was applied through steel balls at the other two corners. A longer flat bar replaced the one used previously to act as a load cell of 25 lb capacity accurate to $\pm.03$ lb. A counterbalance lifted the loading system clear of the element when the screw was retracted. Twist was measured by the instrument shown in figure 6.11. This consisted of a dial gauge mounted on a yoke with the plunger carrying a beam at right angles to the yoke and the plunger. Legs fixed to the yoke and the beam rested on the element at four points which defined the corners of a square of 4.2 in. side concentric with the edges of the element.

Loads were applied at $7\frac{1}{2}$ minute intervals in a sequence similar to that shown in figure 6.10. The maximum load was 1/25 the mean maximum load on the prototype element with the same type of fastening as the model element under test.

6.3 RESULTS

6.3.1 Compression and Shear

6.3.1.1 Data Processing

The data obtained was processed by computer to convert the bridge and gauge readings into action and strain values respectively as tabulated in tables C.2 and C.3 in the appendix. Since the method of fastening in the elements appeared to have little influence on their behaviour in compression, the grand average curves ignoring the fastening method were computed as shown in figures 6.12 and 6.13.

In the shear tests, as the gauges were clipped in place, no zero readings on a standard bar could be taken to determine a zero drift correction. However, as this work was done in the constant temperature

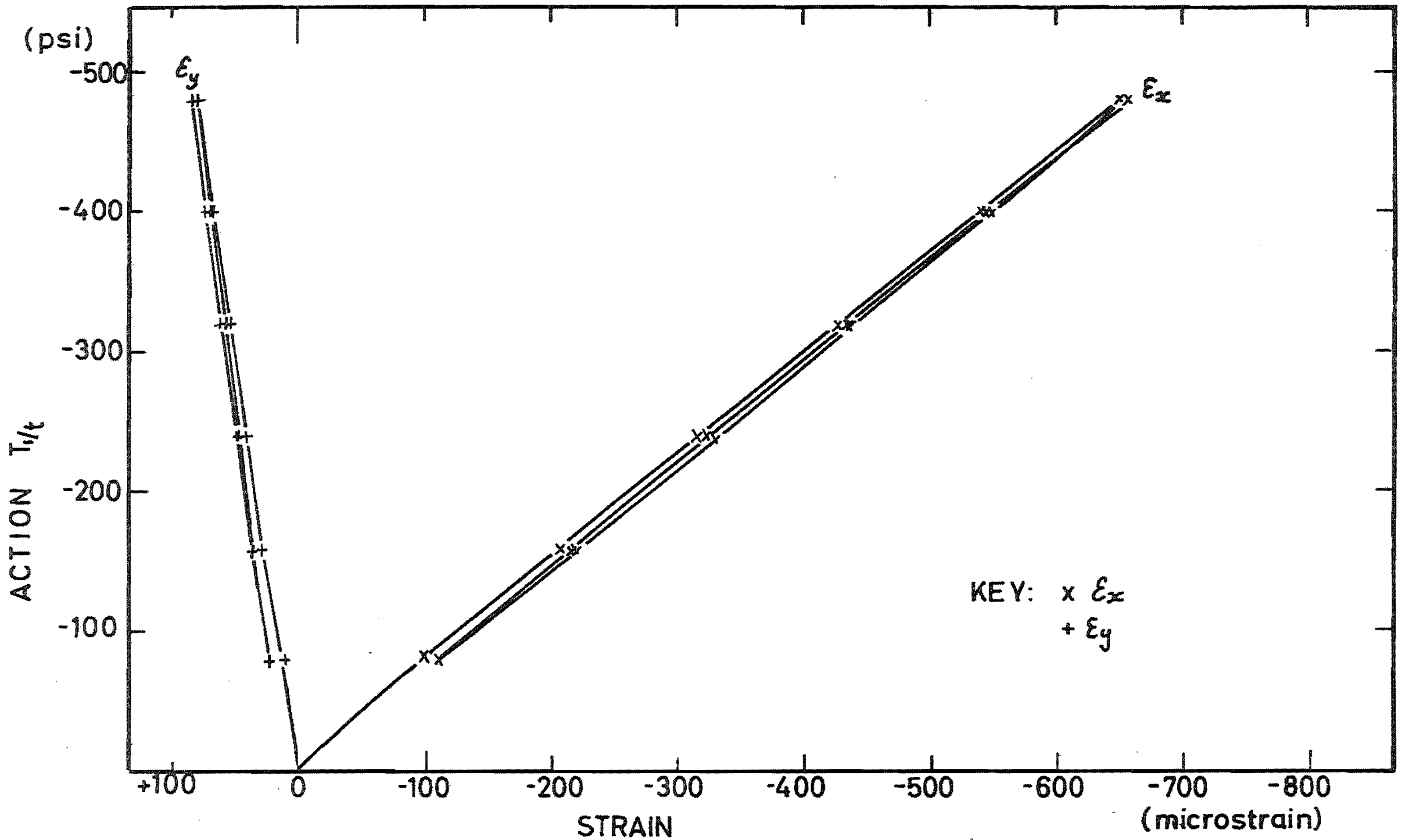


FIG.6.12. Grand average strain-action curves for action T_1 on all model elements.
Average grading modulus = $1{\cdot}142 \times 10^6$ psi.

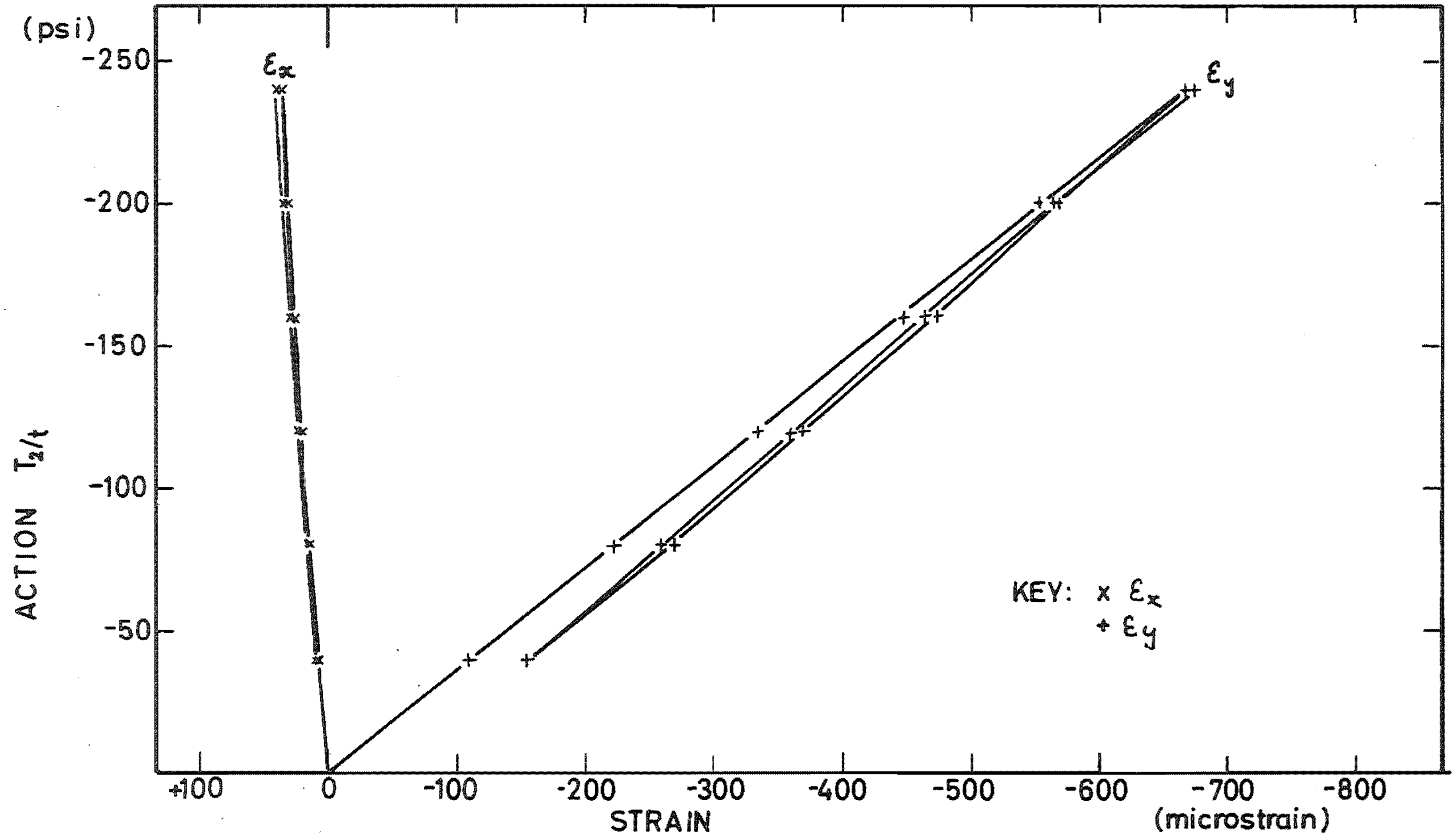


FIG.6.13. Grand average strain - action curves for action T_2 on all model elements.
Average grading modulus = $1{\cdot}142 \times 10^6$ psi.

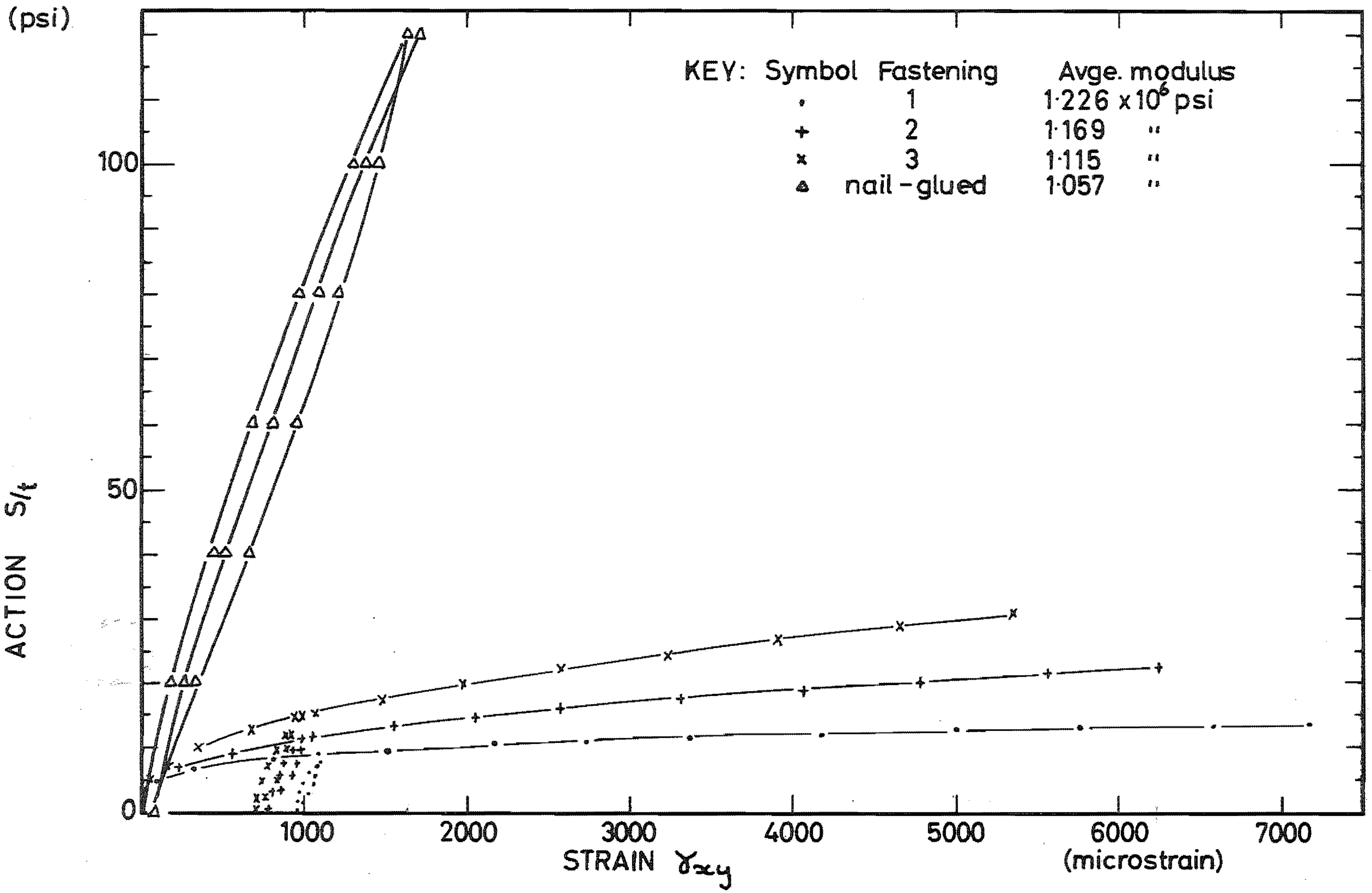


FIG.6.14. Grand average strain-action curves for action S on model elements.

room and the gauges were not handled during a test, any zero drift occurring should be negligible. The strains from the two sides of each element were averaged and the shear strain computed as twice the observed tensile diagonal strain. The grand average curves shown in figure 6.14 typify the behaviour observed in the shear tests.

6.3.1.2 Correlation With Grading Modulus

Values for the term A_{ij} in equation [5.2] :

$$\begin{bmatrix} \varepsilon_x \\ \varepsilon_y \\ \gamma_{xy} \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ S \end{bmatrix} \cdot \frac{1}{t} \quad \ldots\ldots\ldots\ldots \quad [5.2],$$

were obtained in the same manner as for the prototype elements with the exception that values for A_{13}, A_{23}, A_{31} and A_{32} were not obtained as no shear strain measurements were taken in the compression tests, neither were strains measured in directions X and Y in the shear tests. As stated in section 5.2.2 orthotropic theory requires that these constants be zero and it is seen from figures 5.39 and 5.40 that although some comparatively large values for these constants were obtained for the prototype elements, their mean value was effectively zero considering their scatter. Therefore it was not considered necessary to obtain values for these constants for the model elements. Also, in the case of the shear tests the strains in directions X and Y could not be measured, due to the presence of the clipped-on Demec gauges, except perhaps by means of electric resistance strain gauges whose expense was not warranted in view of the above argument.

For load cycle behaviour, the values of A_{11}, A_{12}, A_{21}, A_{22} and A_{33} are shown plotted against the inverse of grading modulus in figure 6.15.

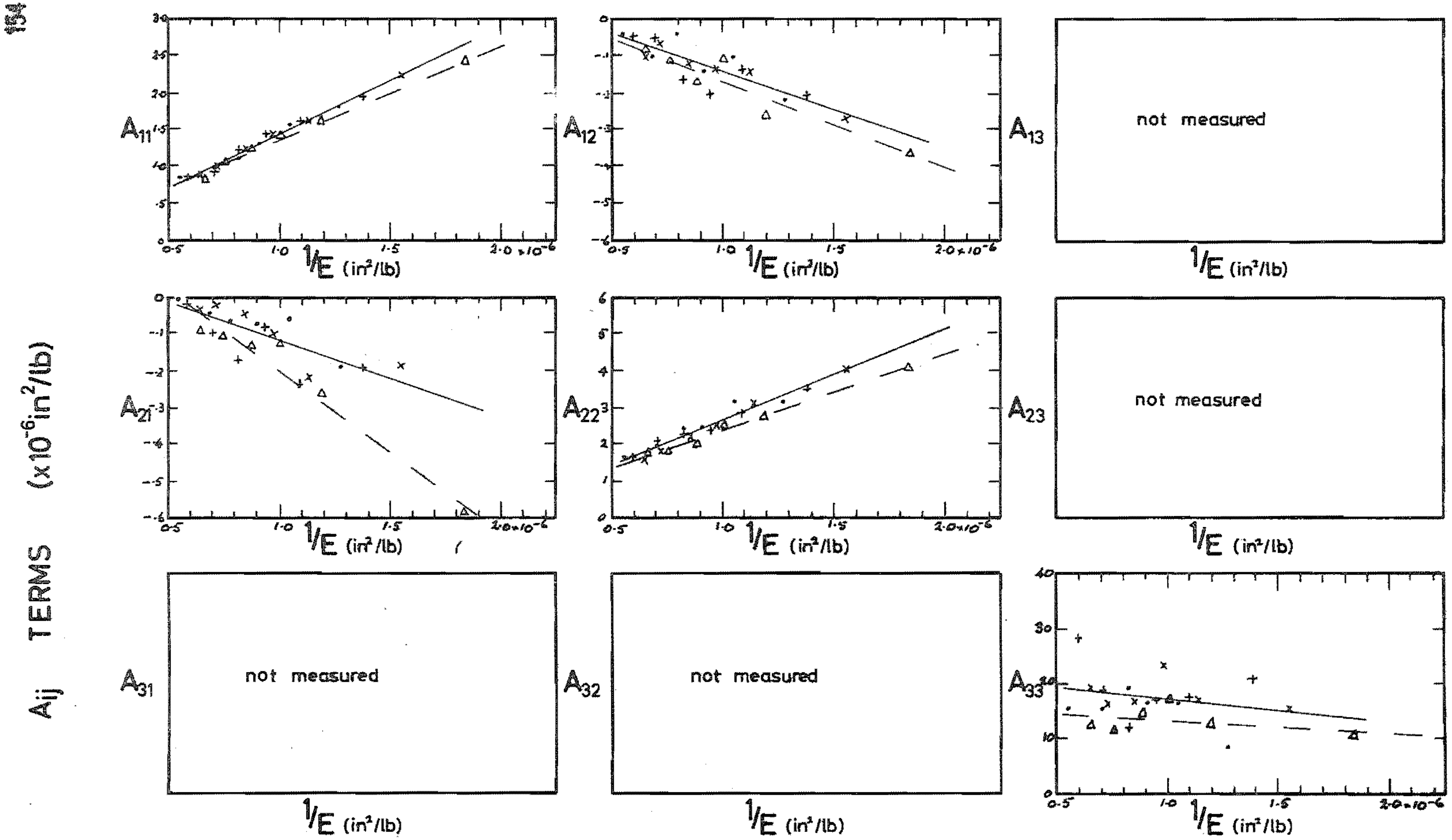


FIG. 6.15. Plot of A_{ij} terms against inverse of grading modulus for load cycle behaviour of model elements.

KEY Symbol	Fastening		Regression lines
·	1	considered together	————
+	2		
x	3		
Δ	nail-glued		— — — —

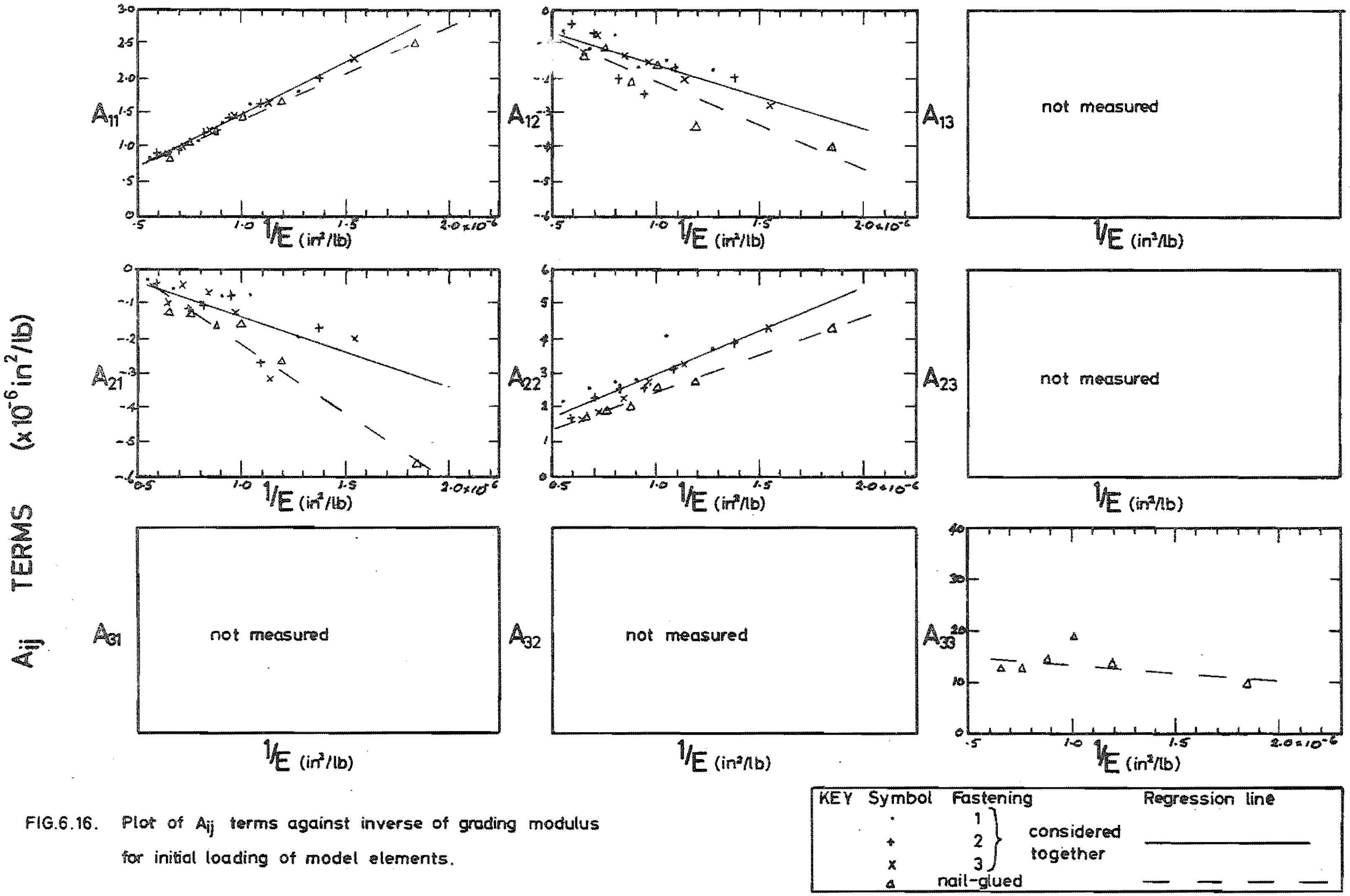


FIG.6.16. Plot of A_{ij} terms against inverse of grading modulus for initial loading of model elements.

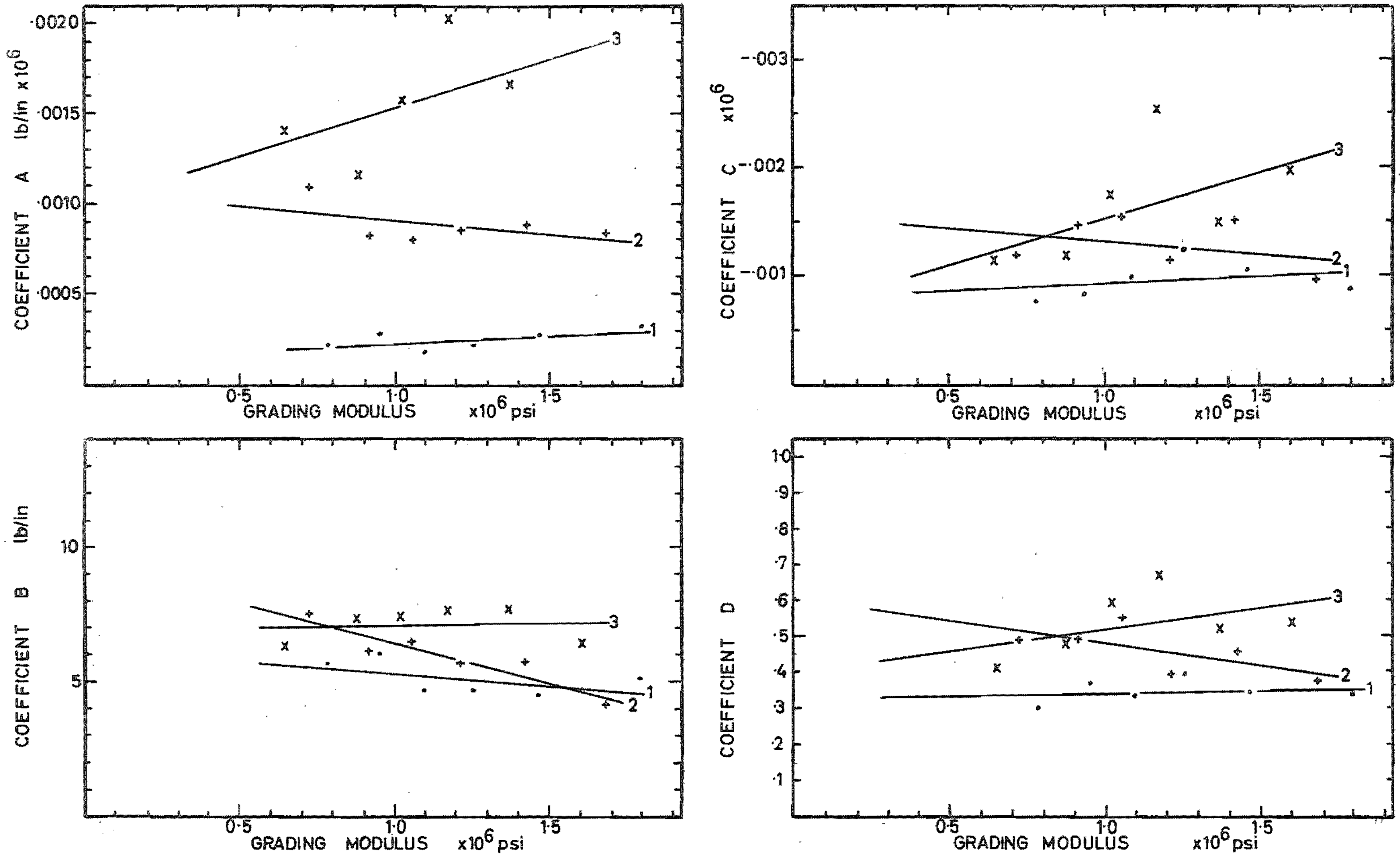


FIG. 6.17 Plot of coefficients A B C and D from the expression $S = (A\gamma_{xy} + B)(1 - e^{C\gamma_{xy}})^D$ fitted to the shear action-shear strain curves of model nailed elements.

KEY Symbol	Fastening	Regression line
·	1	———— 1
+	2	———— 2
x	3	———— 3

For initial loading, figure 6.16 shows these values plotted against $^1/_E$ except for A_{33} for the nailed elements where, as for the prototype elements, the equation:

$$S = (A\gamma_{xy} + B)(1 - e^{C\gamma_{xy}})^D$$ was fitted. The values obtained for A, B, C and D are shown plotted in figure 6.17 against grading modulus. The A_{ij} terms, A, B, C and D and the regression coefficients are tabulated in table 6.1.

Correlations significant at the 1% level were obtained for constants A_{11} and A_{22} both when each type of fastening was considered separately and when they were considered collectively. This indicates that the type of fastening has no influence on these constants and that grading modulus is an extremely good index parameter for them. For constants A_{12} and A_{21} the correlations improved with increase in rigidity of the fastening with highly significant correlations obtained for type 3 fastening, nail-gluing and when the constants were considered collectively. A similar inference to that for the prototype elements is drawn: that the type of fastening does not affect the mean magnitude of the Poisson ratio strain, only the scatter associated with that mean.

The correlations for constant A_{33} were not significant at the 5% level indicating that grading modulus is not a good index parameter for A_{33}.

Considering the behaviour of the nailed elements in shear, as characterised by the coefficients A, B, C and D in table 6.1, only coefficient B for fastening 2 shows significant correlation with E. This, however, appears to be an anomalous result because the correlation is negative and because the other two fastening types do not show a similar trend.

TABLE 6.1 REGRESSION OF A_{ij} CONSTANTS AGAINST $^1/_E$ FOR MODEL ELEMENTS

FASTENING	LABEL	GRADING MODULUS		LOAD CYCLE					INITIAL LOADING				
		E	$^1/_E$	T_1		T_2		S	T_1		T_2		S
				A_{11}	A_{12}	A_{21}	A_{22}	A_{33}	A_{11}	A_{12}	A_{21}	A_{22}	A_{33}
		$X10^6$psi	$X10^{-6}$in.^{2}/lb	$X10^{-6}$in.^{2}/lb					$X10^{-6}$in.^{2}/lb				
1	4	.785	1.275	1.808	-.217	-.185	3.238	8.40	1.847	-.172	-.197	3.710	
	8	.952	1.051	1.534	-.105	-.063	3.255	16.72	1.640	-.147	-.075	4.086	
	12	1.095	.913	1.321	-.142	-.078	2.487	16.48	1.345	-.168	-.079	2.783	
	16	1.258	.795	1.091	-.041	-.071	2.432	19.55	1.095	-.068	-.095	2.768	
	20	1.469	.681	.983	-.109	-.052	2.012	15.45	1.001	-.115	-.055	2.620	
	24	1.798	.556	.837	-.041	-.002	1.741	15.70	.843	-.066	-.029	2.198	
Regression	M			1.396	-.210	-.207	2.275	-8.76	1.481	-.147	-.194	2.409	
Coefficients	C($X10^{-6}$)			.036	.075	.107	.529	23.08	-.006	.007	.082	.911	
Correlation coefficient	r			.993**	-.821*	-.895*	.952**	-.613	.990**	-.802*	-.872*	.874*	
2	3	.722	1.384	1.954	-.204	-.189	3.547	20.80	2.041	-.195	-.168	3.879	
	7	.917	1.091	1.622	-.137	-.241	2.906	17.89	1.630	-.165	-.270	3.110	
	11	1.054	.948	1.409	-.199	-.077	2.406	17.05	1.430	-.241	-.078	2.638	
	15	1.213	.824	1.231	-.165	-.175	2.323	12.27	1.247	-.205	-.113	2.519	
	19	1.425	.702	.957	-.053	-.103	2.120	18.88	.954	-.069	-.115	2.330	
	23	1.681	.595	.892	-.049	-.026	1.621	28.12	.913	-.043	-.047	1.721	
Regression	M			1.410	-.189	-.197	2.302	-4.18	1.493	-.179	-.177	2.531	
Coefficients	C($X10^{-6}$)			.042	.040	-.047	.360	23.03	-.011	.013	.031	.361	
Correlation coefficient	r			.987**	-.782	-.701	.987**	-.229	.995**	-.645	-.639	.985**	
3	2	.646	1.548	2.232	-.272	-.186	4.092	15.30	2.309	-.275	-.203	4.272	
	6	.878	1.140	1.628	-.148	-.216	3.144	17.04	1.662	-.197	-.311	3.295	
	10	1.022	.978	1.445	-.135	-.107	2.636	23.33	1.462	-.151	-.128	2.746	
	14	1.172	.854	1.215	-.121	-.049	2.164	16.77	1.244	-.125	-.065	2.239	
	18	1.371	.729	1.007	-.069	-.028	1.825	16.44	1.002	-.073	-.045	1.906	
	22	1.605	.652	.908	-.113	-.033	1.598	19.36	.918	-.120	-.100	1.662	
Regression	M			1.482	-.197	-.213	2.830	-2.99	1.563	-.207	-.205	2.968	
Coefficients	C($X10^{-6}$)			-.052	.051	.106	-.207	20.98	-.104	.047	.059	-.231	
	r			.999**	-.937**	-.855*	.996**	-.336	.999**	-.957**	-.673	.996**	
1 + 2 + 3	M			1.434	-.201	-.207	2.465	-4.181	1.513	-.186	-.201	2.535	
together	C($X10^{-6}$)			.006	.058	.088	.241	21.42	-.040	.028	.066	.451	
Correlation coefficient	r			.996**	-.850**	-.772**	.970**	-.280	.995**	-.792**	-.702*	.898**	
Nail-glued	1	.543	1.843	2.418	-.361	-.595	4.149	10.55	2.494	-.399	-.575	4.272	9.56
	5	.840	1.190	1.617	-.264	-.266	2.754	12.74	1.660	-.338	-.267	2.812	13.68
	9	.989	1.011	1.407	-.114	-.130	2.534	17.35	1.428	-.161	-.167	2.565	19.10
	13	1.128	.886	1.237	-.172	-.137	2.035	14.74	1.250	-.210	-.171	2.050	14.46
	17	1.309	.764	1.068	-.118	-.119	1.847	11.63	1.078	-.114	-.131	1.879	12.60
	21	1.534	.652	.873	-.095	-.096	1.695	12.44	.875	-.126	-.123	1.717	12.68
Regression	M			1.273	-.229	-.435	2.098	-2.00	1.337	-.251	-.395	2.189	-3.16
Coefficients	C($X10^{-6}$)			.091	.055	.236	.285	15.35	.050	.041	.178	.234	17.03
Correlation coefficient	r			.999**	-.937**	-.976**	.996**	-.350	.999**	.911*	-.979**	.996**	-.432
All	M			1.348	-.220	-.321	2.232	-4.261	1.419	-.226	-.301	2.251	
together	C($X10^{-6}$)			.067	.068	.174	.379	20.55	.027	.053	.139	.578	
Correlation coefficient	r			.992**	-.883**	-.834**	.956**	-.321	.991**	-.836**	-.809**	.877**	

A_{33} has no meaning for nailed elements on initial loading

* significant at the 5% level

** significant at the 1% level

TABLE 6.1 CONTINUED - Values of A, B, C and D in equation $S = (A\delta_{xy}+B)(1-e^{C\delta_{xy}})^D$ and statistics for regression against grading modulus

FASTENING	ELEMENT LABEL	GRADING MODULUS X10^{6}psi	A X10^{6}lb/in.	B lb/in.	C X10^6	D
1	4	.785	.000219	5.646	-.000757	.2989
	8	.952	.000286	6.010	-.000830	.3671
	12	1.095	.000177	4.623	-.000988	.3298
	16	1.258	.000210	4.465	-.001237	.3938
	20	1.469	.000276	4.464	-.001046	.3425
	24	1.798	.000321	5.154	-.000856	.3346
Regression statistics		M	.0000879	-.848	-.000137	.0167
		C(X10^6)	.0001405	6.100	-.000785	.3239
		r	.590	-.474	-.286	.188
2	3	.722	.001090	7.451	-.001176	.4848
	7	.917	.000832	6.098	-.001453	.4880
	11	1.054	.000793	6.443	-.001512	.5482
	15	1.213	.000850	5.616	-.001115	.3890
	19	1.425	.000887	5.705	-.001488	.4566
	23	1.681	.000827	4.072	-.000943	.3716
Regression statistics		M	-.000157	-2.976	.000248	-.1279
		C(X10^6)	.001062	9.375	-.001571	.6058
		r	-.506	-.931*	.366	-.672
3	2	.646	.001399	6.224	-.001121	.4059
	6	.878	.001153	7.301	-.001158	.4782
	10	1.022	.001564	7.355	-.001735	.5872
	14	1.172	.002024	7.557	-.002520	.6684
	18	1.371	.001658	7.630	-.001466	.5177
	22	1.605	.001755	6.334	-.001946	.5331
Regression statistics		M	.000536	.213	-.000849	.1213
		C(X10^6)	.000994	6.830	-.000711	.3976
		r	.617	.117	-.552	.460

* significant at the 1% level

Figure 6.17 shows that the type of fastening has a marked effect on the value of coefficient A.

6.3.2 Bending and Torsion

6.3.2.1 Data Processing

The strain bridge and dial gauge readings were processed by computer to produce the action and curvature values tabulated in table C.4. The grand average curves of these values, shown in figures 6.18 to 6.20, indicate the general behaviour observed. In the case of action M_2, the nailing density had little effect on the behaviour of these elements and therefore nailing patterns 1, 2 and 3 have been averaged together.

6.3.2.2 Correlation With Grading Modulus

Values for terms B_{11}, B_{22} and B_{33} only in equation [5.3]:

$$\begin{bmatrix} k_x \\ k_y \\ k_{xy} \end{bmatrix} = \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \begin{bmatrix} M_1 \\ M_2 \\ H \end{bmatrix} \cdot \frac{12}{t^3} \quad \ldots\ldots\ldots\ldots \quad [5.3]$$

were calculated in a manner similar to the prototype elements. Only constants B_{11}, B_{22} and B_{33} were measured in the model tests. B_{12}, B_{13}, B_{21} and B_{23} were not measured because the narrow element did not permit it while B_{31} and B_{32} were not measured because the prototype tests indicated that these constants may be considered zero, and because of difficulties of instrumentation on the small elements.

For load cycle behaviour the values of B_{11}, B_{22} and B_{33} are shown plotted against the inverse of grading modulus in figure 6.22 while figure 6.23 shows their values for initial loading. These constants and their regression coefficients are tabulated in table 6.2.

TABLE 6.2 REGRESSION OF B_{ij} CONSTANTS AGAINST $^1/_E$ FOR MODEL ELEMENTS

BENDING ACTION M_1

FASTENING	LABEL	GRADING MODULUS E ($X10^6$psi)	GRADING MODULUS $^1/_E$ ($X10^{-6}$in.^{2}/lb)	B_{11} LOAD CYCLE ($X10^{-6}$in.^{2}/lb)	B_{11} INITIAL LOADING ($X10^{-6}$in.^{2}/lb)
1	3	.883	1.133	4.697	4.855
	6A	1.055	.948	2.908	3.531
	8B	1.169	.855	3.117	3.627
	11	1.331	.751	3.174	3.751
	14A	1.545	.647	3.414	3.878
	16B	1.748	.572	1.077	1.354
Regression			M	4.334	4.166
Coefficients			C($X10^{-6}$)	-.479	.093
Correlation coeff.			r	.766	.743
2	2B	.848	1.179	2.150	2.862
	5	1.013	.988	2.506	3.043
	8A	1.144	.874	1.717	2.240
	10B	1.295	.772	1.755	2.169
	13	1.464	.683	1.809	2.180
	16A	1.703	.583	1.755	2.233
Regression			M	.978	1.448
Coefficients			C($X10^{-6}$)	1.121	1.229
Correlation coeff.			r	.668	.799
3	2A	.746	1.341	1.496	1.648
	4B	.992	1.008	1.304	1.606
	7	1.118	.895	.958	1.128
	10A	1.248	.802	.962	1.112
	12B	1.419	.705	1.038	1.213
	15	1.638	.611	1.007	1.237
Regression			M	.744	.718
Coefficients			C($X10^{-6}$)	.462	.683
Correlation coeff.			r	.872*	.777
1 + 2 + 3			M	1.201	1.206
together			C($X10^{-6}$)	1.023	1.398
Correlation coeff.			r	.247	.230
Nail-glued	1	.545	1.835	1.731	1.776
	4A	.952	1.051	.932	.949
	6B	1.097	.912	.801	.818
	9	1.199	.834	.700	.714
	12A	1.377	.726	.668	.676
	14B	1.588	.630	.569	.573
Regression			M	.975	1.008
Coefficients			C($X10^{-6}$)	-.073	-.088
Correlation coeff.			r	.998**	.998**
All			M	.615	.506
together			C($X10^{-6}$)	1.213	1.599
Correlation coeff.			r	.165	.119

BENDING ACTION M_2

FASTENING	LABEL	GRADING MODULUS E ($X10^6$psi)	GRADING MODULUS $^1/_E$ ($X10^{-6}$in.^{2}/lb)	B_{22} LOAD CYCLE ($X10^{-6}$in.^{2}/lb)	B_{22} INITIAL LOADING ($X10^{-6}$in.^{2}/lb)
1	3A	.882	1.134	16.23	18.14
	5B	1.033	.968	14.51	16.78
	8	1.172	.853	15.33	16.77
	11A	1.342	.745	10.82	12.10
	13B	1.523	.656	9.75	10.39
	16	1.770	.565	9.38	9.95
Regression			M	13.40	16.30
Coefficients			C($X10^{-6}$)	1.68	.66
Correlation coeff.			r	.925**	.942**
2	2	.858	1.165	18.69	21.89
	5A	1.022	.979	13.80	15.00
	7B	1.107	.904	12.97	13.87
	10	1.265	.791	10.85	11.80
	13A	1.492	.670	8.78	9.31
	15B	1.673	.598	9.46	
Regression			M	17.75	21.68
Coefficients			C($X10^{-6}$)	-2.81	-4.90
Correlation coeff.			r	.983**	.967**
3	1B	.730	1.370	20.53	22.66
	4	1.000	1.000	15.82	16.48
	7A	1.117	.895	11.08	11.51
	9B	1.230	.813	13.28	14.32
	12	1.417	.706	9.53	9.83
	15A	1.653	.605	10.09	10.60
Regression			M	14.71	16.85
Coefficients			C($X10^{-6}$)	.17	-.90
Correlation coeff.			r	.945**	.942**
1 + 2 + 3			M	15.07	17.69
together			C($X10^{-6}$)	-.12	-1.22
Correlation coeff.			r	.944**	.936**
	1A	.564	1.772	13.98	14.61
	3B	.933	1.071	11.96	12.38
	6	1.092	.916	10.18	10.87
	9A	1.205	.830	9.56	10.09
	11B	1.358	.736	10.08	10.60
	14	1.603	.624	8.71	8.90
Regression			M	4.45	4.67
Coefficients			C($X10^{-6}$)	6.33	6.61
Correlation coeff.			r	.959**	.961**
All			M	8.51	9.61
together			C($X10^{-6}$)	4.70	4.71
Correlation coeff.			r	.718**	.684**

TORSIONAL ACTION H

FASTENING	LABEL	GRADING MODULUS E ($X10^6$psi)	GRADING MODULUS $^1/_E$ ($X10^{-6}$in.^{2}/lb)	B_{33} LOAD CYCLE ($X10^{-6}$in.^{2}/lb)	B_{33} INITIAL LOADING ($X10^{-6}$in.^{2}/lb)
1	4	.977	1.024	19.363	34.298
	8	1.169	.855	20.099	35.340
	12	1.405	.712	21.192	32.381
	16	1.746	.573	16.056	30.629
Regression			M	5.56	9.08
Coefficients			C($X10^{-6}$)	14.78	25.98
Correlation coeff.			r	.486	.841
2	3	.907	1.103	23.519	33.310
	7	1.123	.890	12.338	27.535
	11	1.334	.750	12.104	25.235
	15	1.653	.605	12.77	25.902
Regression			M	21.45	15.68
Coefficients			C($X10^{-6}$)	-2.77	14.87
Correlation coeff.			r	.817	.905
3	2	.812	1.232	11.017	22.963
	6	1.078	.927	9.285	19.014
	10	1.278	.783	9.657	20.554
	14	1.579	.633	9.732	19.929
Regression			M	2.19	4.73
Coefficients			C($X10^{-6}$)	7.97	16.38
Correlation coeff.			r	.740	.716
1 + 2 + 3			M	4.39	3.16
together			C($X10^{-6}$)	11.07	24.60
Correlation coeff.			r	.178	.110
Nail-glued	1	.658	1.520	7.787	8.810
	5	1.028	.973	7.002	7.992
	9	1.215	.823	7.663	8.940
	13	1.489	.672	7.539	8.054
Regression			M	.29	.59
Coefficients			C($X10^{-6}$)	7.20	7.86
Correlation coeff.			r	.316	.442
All			M	-1.32	-7.51
together			C($X10^{-6}$)	14.11	29.16
Correlation coeff.			r	-.061	-.193

* significant at the 5% level
** significant at the 1% level

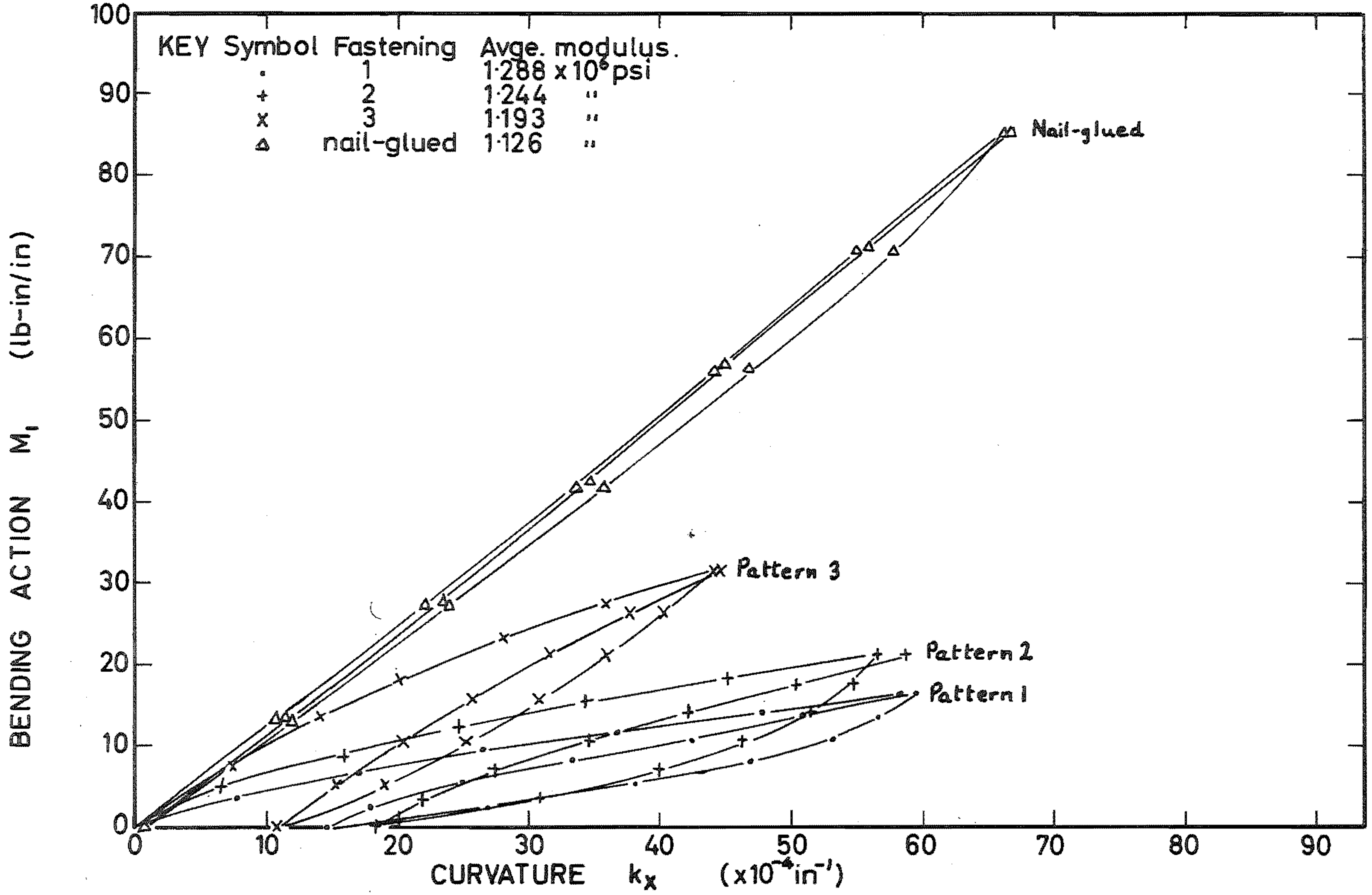


FIG.6.18. Grand average curvature-action curves for action M_1 on model elements.

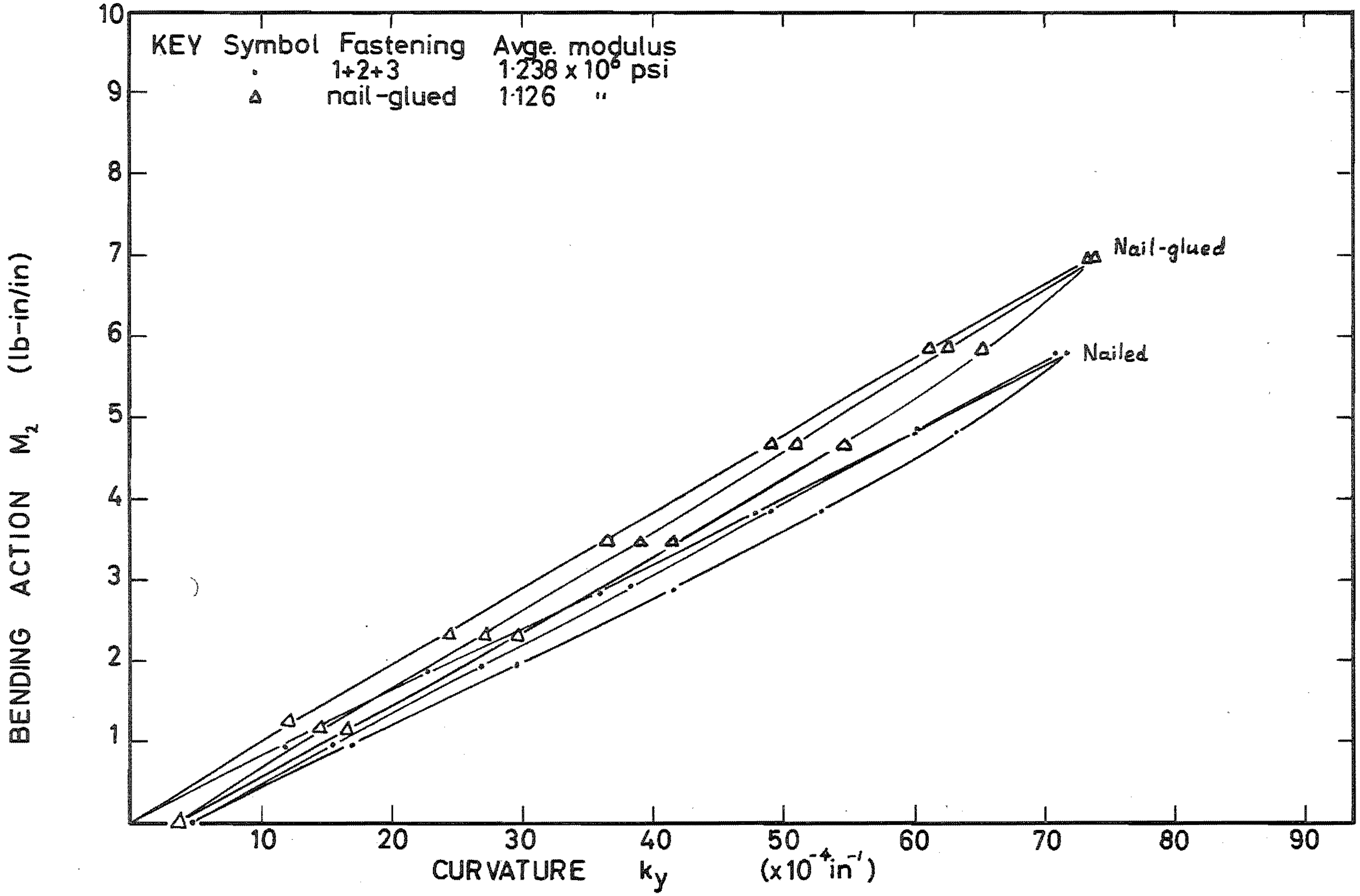


FIG.6.19. Grand average action-curvature curves for action M_2 on model elements.

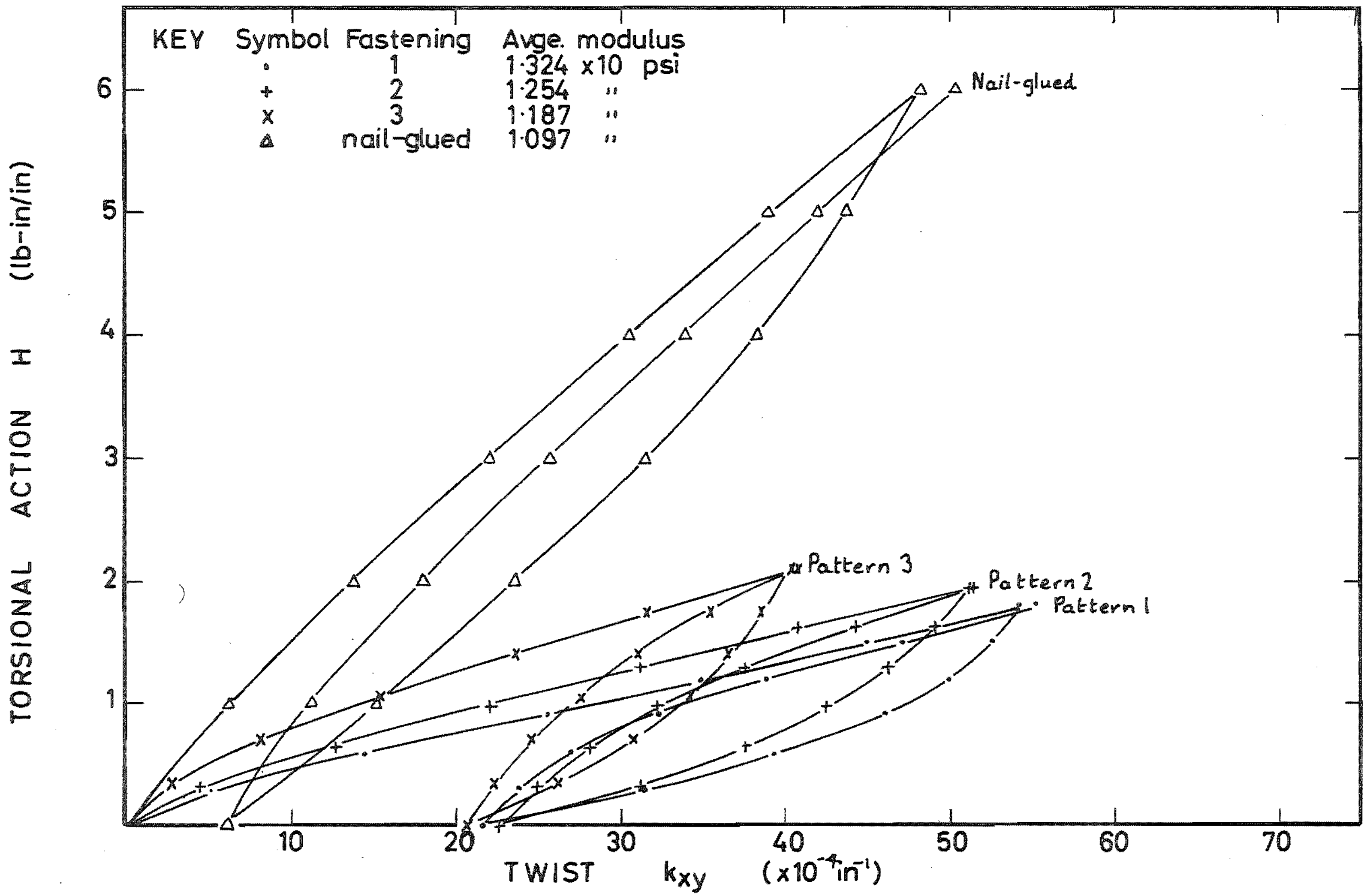
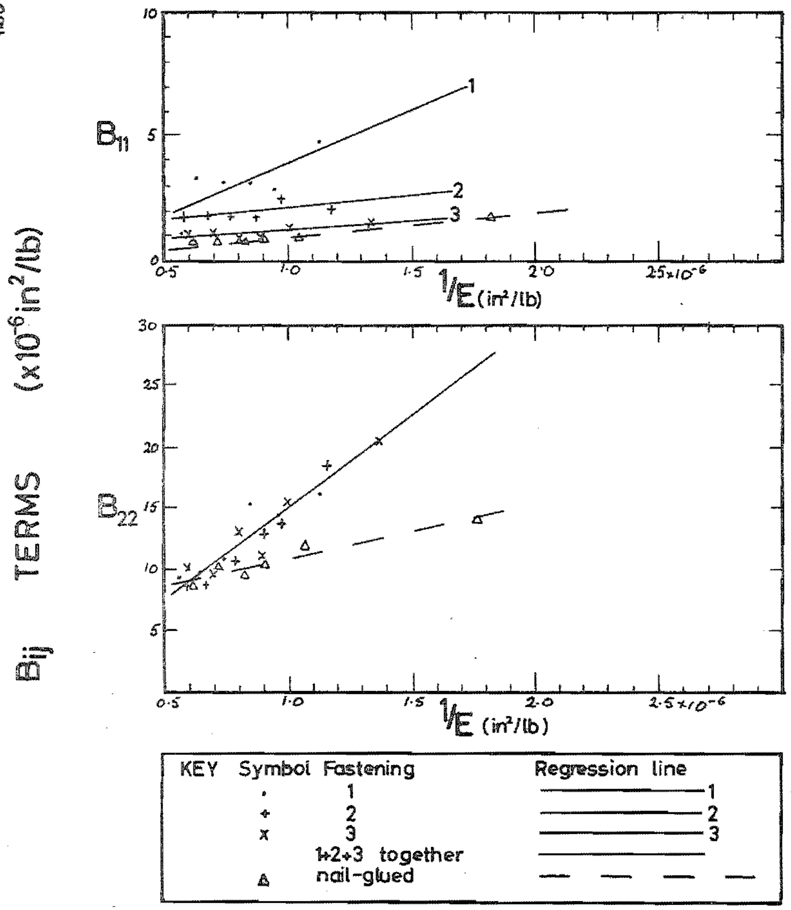


FIG.6.20. Grand average action-twist curves for action H on model elements.



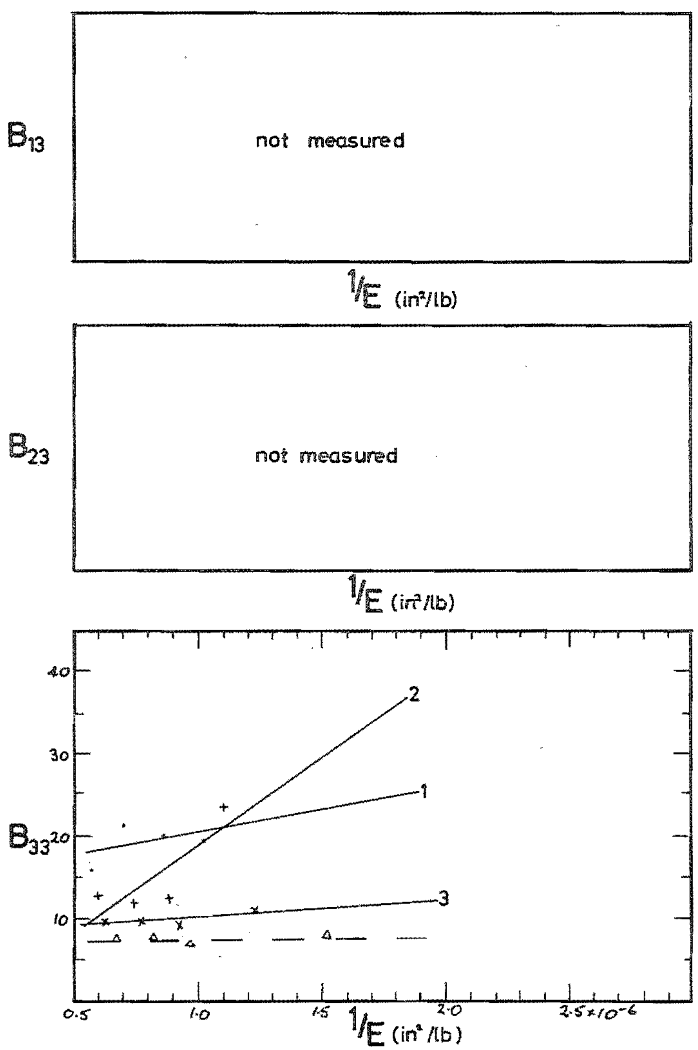


FIG.6.22. Plot of Bij terms against inverse of grading modulus for load cycle behaviour of model elements.

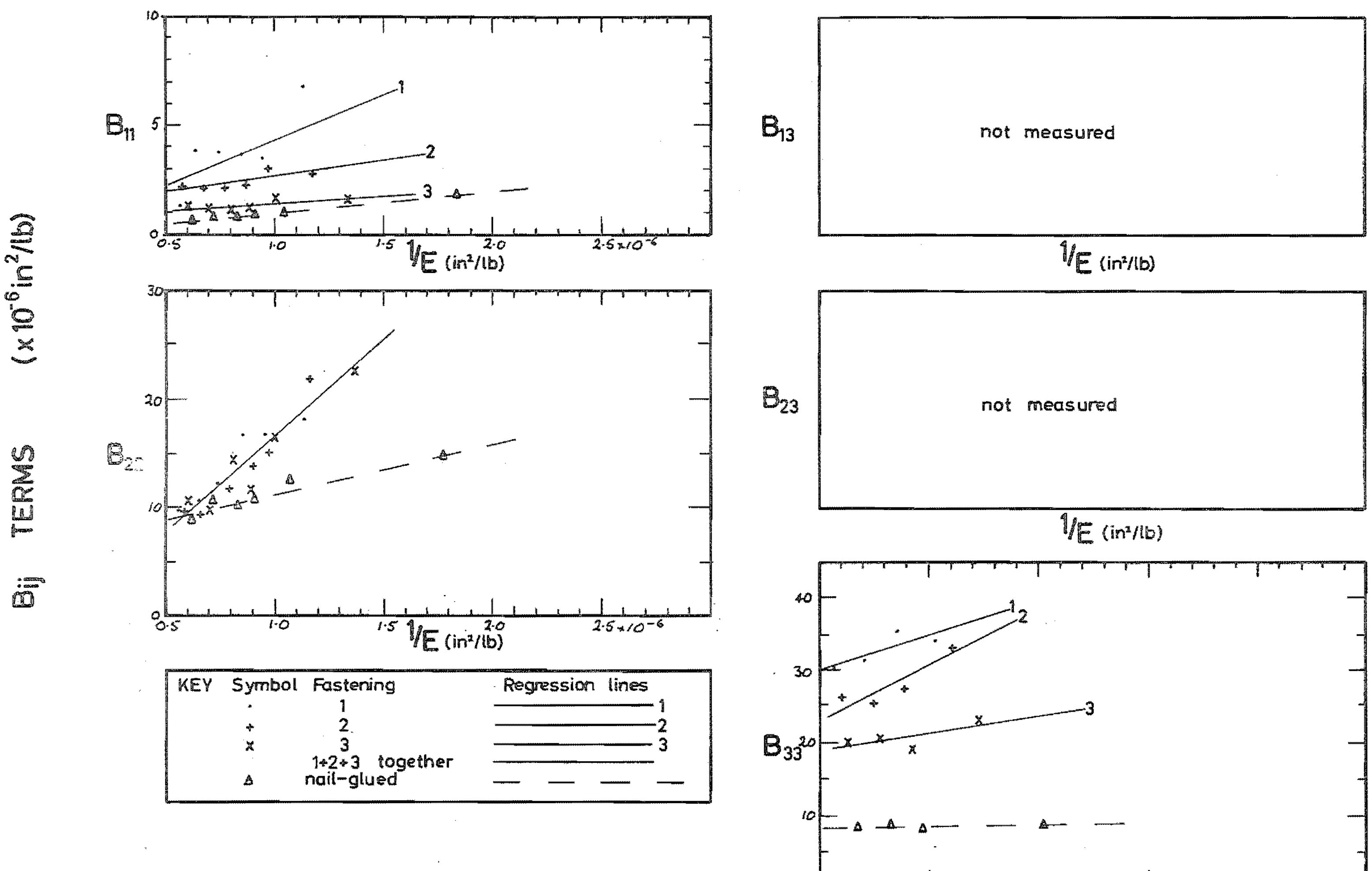


FIG. 6.23. Plot of B_{ij} terms against inverse of grading modulus for initial loading of model elements.

Similar tendencies to those for the prototype constants were shown by the model constants except that the correlation coefficients were slightly lower for the latter. For constant B_{11} the correlations for each type were high, especially for nail-gluing, while collectively the correlations were very low. This shows that B_{11} is significantly dependent on both the grading modulus and the type of fastening.

Constant B_{22} showed correlations significant at the 1% level for both individual and collective regressions. Thus B_{22} is dependent only upon grading modulus.

No significant correlations were found for constant B_{33}, showing that B_{33} is not dependent upon grading modulus.

6.4 COMPARISON OF MODEL VALUES WITH THEORY

Values for A_{ij} and B_{ij} for prototype elements for a value of E of 1.077×10^6 psi were tabulated in table 5.7. For the model elements, this value of E gives the values in table 6.3.

The values for A_{11} and A_{22} on load cycling are seen to be very close to the theoretical values. The values for initial loading are slightly higher but are nevertheless very close to the theoretical values also.

The constants A_{12} are generally greater than the constants A_{21}. This trend is opposite to that expected for the nailed elements. Also the constants A_{12} are about twice the theoretical values. The reason for this is not immediately apparent. The constants A_{21} are about one tenth the theoretical values for the nailed elements. This indicates that the resistance the nails offer to relative movement between the layers is not insignificant, as was assumed in deriving the theoretical values.

TABLE 6.3 Values of A_{ij} and B_{ij} for model elements with a mean grading modulus of 1.077×10^6 psi

TYPE OF FASTENING			
1	2	3	NAIL-GLUED
$A_{ij} \times 10^{-6}$ in.^{2}/lb - LOAD CYCLE			
$\begin{bmatrix} 1.332 & -.120 & . \\ -.085 & 2.641 & . \\ . & . & 14.95 \end{bmatrix}$	$\begin{bmatrix} 1.351 & -.135 & . \\ -.230 & 2.496 & . \\ . & . & 19.15 \end{bmatrix}$	$\begin{bmatrix} 1.324 & -.132 & . \\ -.092 & 2.421 & . \\ . & . & 18.20 \end{bmatrix}$	$\begin{bmatrix} 1.273 & -.158 & . \\ -.168 & 2.253 & . \\ . & . & 13.49 \end{bmatrix}$
$A_{ij} \times 10^{-6}$ in.^{2}/lb - INITIAL LOADING			
$\begin{bmatrix} 1.369 & -.129 & . \\ -.098 & 3.148 & . \\ . & . & ** \end{bmatrix}$	$\begin{bmatrix} 1.375 & -.153 & . \\ -.133 & 2.711 & . \\ . & . & ** \end{bmatrix}$	$\begin{bmatrix} 1.347 & -.145 & . \\ -.131 & 2.525 & . \\ . & . & ** \end{bmatrix}$	$\begin{bmatrix} 1.291 & -.192 & . \\ -.189 & 2.266 & . \\ . & . & 14.10 \end{bmatrix}$
$A_{ij} \times 10^{-6}$ in.^{2}/lb - THEORETICAL			
$\begin{bmatrix} 1.324 & -.064 & . \\ -.591 & 2.442 & . \\ . & . & 632* \end{bmatrix}$	$\begin{bmatrix} 1.324 & -.064 & . \\ -.591 & 2.442 & . \\ . & . & 316* \end{bmatrix}$	$\begin{bmatrix} 1.324 & -.064 & . \\ -.591 & 2.442 & . \\ . & . & 158* \end{bmatrix}$	$\begin{bmatrix} 1.314 & -.092 & . \\ -.092 & 2.424 & . \\ . & . & 11.10 \end{bmatrix}$
$B_{ij} \times 10^{-6}$ in.^{2}/lb - LOAD CYCLE			
$\begin{bmatrix} 3.545 & . & . \\ . & 14.12 & . \\ . & . & 19.94 \end{bmatrix}$	$\begin{bmatrix} 2.029 & . & . \\ . & 13.67 & . \\ . & . & 17.15 \end{bmatrix}$	$\begin{bmatrix} 1.153 & . & . \\ . & 13.83 & . \\ . & . & 10.00 \end{bmatrix}$	$\begin{bmatrix} .832 & . & . \\ . & 10.46 & . \\ . & . & 7.47 \end{bmatrix}$
$B_{ij} \times 10^{-6}$ in.^{2}/lb - INITIAL LOADING			
$\begin{bmatrix} 3.961 & . & . \\ . & 15.79 & . \\ . & . & 35.08 \end{bmatrix}$	$\begin{bmatrix} 2.573 & . & . \\ . & 15.23 & . \\ . & . & 29.43 \end{bmatrix}$	$\begin{bmatrix} 1.350 & . & . \\ . & 14.15 & . \\ . & . & 20.77 \end{bmatrix}$	$\begin{bmatrix} .848 & . & . \\ . & 10.45 & . \\ . & . & 8.41 \end{bmatrix}$
$B_{ij} \times 10^{-6}$ in.^{2}/lb - THEORETICAL			
$\begin{bmatrix} 0.942 & . & . \\ . & 9.828 & . \\ . & . & 57.68 \end{bmatrix}$	$\begin{bmatrix} 0.942 & . & . \\ . & 9.828 & . \\ . & . & 57.68 \end{bmatrix}$	$\begin{bmatrix} 0.942 & . & . \\ . & 9.828 & . \\ . & . & 57.68 \end{bmatrix}$	$\begin{bmatrix} 0.938 & -2.26 & . \\ -.264 & 9.788 & . \\ . & . & 11.10 \end{bmatrix}$

* Values refer to load cycling only

** A_{33} has no meaning for nailed elements

The values of A_{33} for the nail-glued elements are higher than expected. The lack of edge-gluing between the boards in each layer is possibly responsible for this since it would cause regions of high local stress and hence produce a more flexible membrane than one with continuous layers. For the nailed elements on load cycling, the theoretical values of A_{33} are considerably in error. The friction between the layers is probably responsible and, although it is an uncertain quantity as assumed, it is not an insignificant one. Also the nailed elements do not show an increase in stiffness with nailing density as was expected.

The values for B_{11} and B_{22} for the nail-glued elements agree well with theory with little difference between initial loading and load cycling values. The values obtained for B_{33} are lower than the theoretical values, indicating that the nail-glued elements are more rigid than expected. This contrasts with the A_{33} values which were higher than expected although the theoretical state of stress is one of pure shear in both cases.

For the nailed elements, B_{11} values show a decrease with increasing nailing density as shown in figure 6.24. The trend is such that the value of B_{11} for nail-glued elements should be obtained from nailed elements with a nailing density about 50% greater than that in pattern 3. Considering the values of B_{11} for prototype elements as in figure 5.47, a similar trend is found where the stiffness of the nail-glued elements should be equalled at a nailing density of 40 nails/sq ft.

The B_{22} values for nailed elements are slightly influenced by nailing density and show about 10 to 15% decrease from initial loading to load cycling. Their values are close to 15.5×10^{-6} which may be calculated for these elements if the outer layer which is in tension

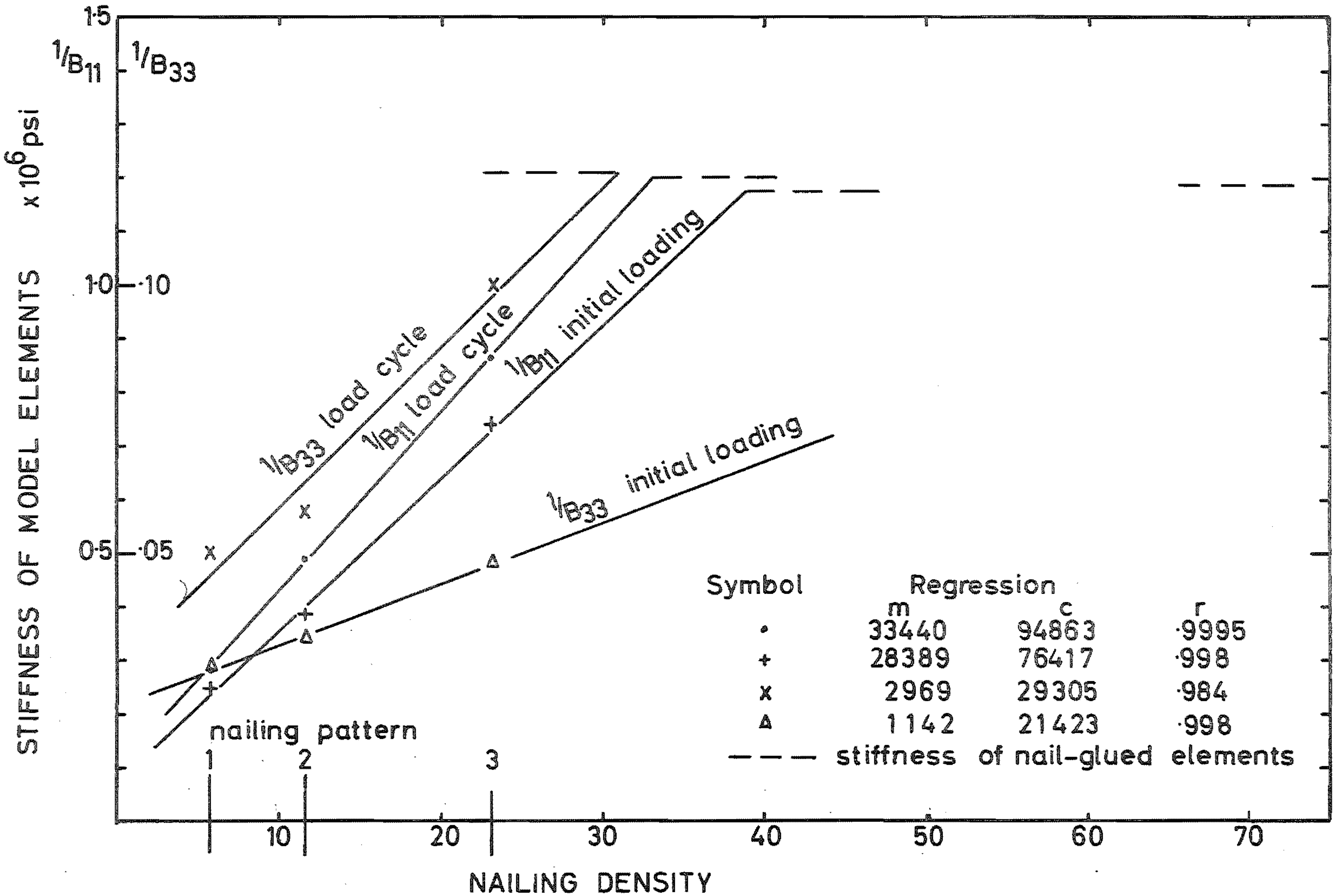


FIG.6.24. Showing the effect of nailing density on stiffness of model nailed elements under actions M_1 and H.

perpendicular to the direction of its boards is ignored. If the upper layer (which is in compression) were also ignored a value of 25 X 10^{-6} would be calculated.

In figure 6.24 the values obtained for B_{33} for nailed elements show a similar trend to the B_{11} values in that the stiffnesses of the nail-glued elements should be equalled at a nailing density 1.5 times that of pattern 3 for load cycling and at 3.7 times for initial loading. On the other hand the theoretical values are approached at zero nailing density. This shows that the theoretical derivation of B_{33}, which assumes no contribution from the nails, is substantially correct.

6.5 COMPARISON OF MODEL AND PROTOTYPE

To compare the elastic constants of the model and prototype elements, the values in table 6.3 have been divided by the corresponding values in table 5.7 and are tabulated in table 6.4.

TABLE 6.4 Ratios between A_{ij} and B_{ij} constants of model and prototype elements at a grading modulus of 1.077×10^{6} psi

TYPE OF FASTENING			
1	2	3	NAIL-GLUED
Ratios of A_{ij} - LOAD CYCLE			
$\begin{bmatrix} 1.038 & 1.935 & \cdot \\ 1.604 & 1.011 & \cdot \\ \cdot & \cdot & 0.573 \end{bmatrix}$	$\begin{bmatrix} 1.023 & 2.596 & \cdot \\ 2.758 & 0.953 & \cdot \\ \cdot & \cdot & 0.831 \end{bmatrix}$	$\begin{bmatrix} 0.978 & 3.220 & \cdot \\ 0.458 & 0.920 & \cdot \\ \cdot & \cdot & 0.942 \end{bmatrix}$	$\begin{bmatrix} 1.002 & 2.772 & \cdot \\ 1.647 & 0.946 & \cdot \\ \cdot & \cdot & 0.807 \end{bmatrix}$
Ratios of A_{ij} - INITIAL LOADING			
$\begin{bmatrix} 1.060 & 1.870 & \cdot \\ 0.377 & 1.036 & \cdot \\ \cdot & \cdot & \cdot \end{bmatrix}$	$\begin{bmatrix} 1.051 & 2.684 & \cdot \\ 1.157 & 0.987 & \cdot \\ \cdot & \cdot & \cdot \end{bmatrix}$	$\begin{bmatrix} 0.992 & 2.231 & \cdot \\ 1.083 & 0.951 & \cdot \\ \cdot & \cdot & \cdot \end{bmatrix}$	$\begin{bmatrix} 0.998 & 2.667 & \cdot \\ 1.673 & 0.983 & \cdot \\ \cdot & \cdot & 0.763 \end{bmatrix}$
Ratios of B_{ij} - LOAD CYCLE			
$\begin{bmatrix} 0.758 & \cdot & \cdot \\ \cdot & 0.928 & \cdot \\ \cdot & \cdot & 1.399 \end{bmatrix}$	$\begin{bmatrix} 0.849 & \cdot & \cdot \\ \cdot & 0.837 & \cdot \\ \cdot & \cdot & 1.228 \end{bmatrix}$	$\begin{bmatrix} 0.809 & \cdot & \cdot \\ \cdot & 0.984 & \cdot \\ \cdot & \cdot & 0.928 \end{bmatrix}$	$\begin{bmatrix} 0.970 & \cdot & \cdot \\ \cdot & 0.740 & \cdot \\ \cdot & \cdot & 0.830 \end{bmatrix}$
Ratios of B_{ij} - INITIAL LOADING			
$\begin{bmatrix} 0.708 & \cdot & \cdot \\ \cdot & 1.010 & \cdot \\ \cdot & \cdot & 0.940 \end{bmatrix}$	$\begin{bmatrix} 0.747 & \cdot & \cdot \\ \cdot & 0.917 & \cdot \\ \cdot & \cdot & 0.784 \end{bmatrix}$	$\begin{bmatrix} 0.630 & \cdot & \cdot \\ \cdot & 0.989 & \cdot \\ \cdot & \cdot & 0.667 \end{bmatrix}$	$\begin{bmatrix} 0.946 & \cdot & \cdot \\ \cdot & 0.728 & \cdot \\ \cdot & \cdot & 0.799 \end{bmatrix}$

The agreement between the values of A_{11} and of A_{22} is close, with the model values ranging from 6% above to 8% below the prototype values.

The model values of A_{12} and A_{21} are considerably higher than the prototype values. This is probably due to a difference between the model and prototype compression rigs in that in the model rig the loaded edges could move laterally, because the alignment segments rolled on steel balls, whereas in the prototype rig the loaded edges were probably restrained because the rubber strip insertion was too stiff or too thin and the alignment segments could not slide laterally.

The model values of A_{33} are from 6 to 43% below the prototype values. The greatest difference occurs with type 1 fastening where the model value appears to be in error since the model values should show a decrease with increasing nailing density similar to the prototype values. The 15 to 20% greater relative stiffness of the model nailed joints on initial loading could account for the greater stiffness of the model nailed elements in shear although the "elastic stiffness" values, e, of the model and prototype joints were almost identical. The quantity of glue in the model nail-glued elements was 50% greater than required for strict model similitude. The extra glue may have squeezed between the boards to provide some edge bonding which is likely to have a significant effect on their shear stiffness. On the other hand the model boards were not tongue-and grooved and therefore there should be less shear transfer by friction between adjacent boards in each layer in the model elements. If the extra glue in the model elements is responsible for their greater stiffness then it is likely that the greater relative stiffness of the model nailed joints is responsible for the greater relative stiffness of the model nailed elements. Otherwise the discrepancy is unexplained.

Considering the initial loading of the model and prototype nailed elements in shear, values of A, B, C and D relative to a grading modulus of 1.077×10^6 psi are tabulated in table 6.5.

TABLE 6.5 Comparison of values of A, B, C and D for model and prototype elements at a grading modulus of 1.077×10^6 psi

	FASTENING	A	B	C	D
	1	.002095	22.36	-.001259	.4834
Prototype	2	.003213	26.06	-.001196	.4906
	3	.006139	37.14	-.002224	.6996
	1	.0002352	5.187	-.000933	.3419
Model	2	.0008929	6.170	-.001304	.4681
	3	.0015713	7.059	-.001625	.5282
	Scale factors	5	5	1	1
	1	.001176	25.93	-.000933	.3419
Model values scaled	2	.004465	30.85	-.001304	.4681
	3	.007856	35.30	-.001625	.5282

When substituted into the equation $S = (A\gamma_{xy} + B)(1 - e^{C\gamma_{xy}})^D$ these coefficients define the curves shown in figure 6.25. In this figure the model and prototype elements are seen to give dissimilar stress - strain curves, differing, in the case of fastening type 1 by up to 30% in stress values at low values of strain.

For type 2 fastening, the model curve lies above the prototype curve by 24 to 28% while for type 3 fastening the model and prototype curves agree reasonably well up to about 2000 microstrain.

The model values of B_{11} are from 15 to 37% less than the prototype for nailed elements while the difference is only 3 to 5% for the nail-glued elements. The marked dependence of B_{11} on nailing density as shown in figure 6.24 suggests that the greater relative stiffness of the model joints on initial loading is responsible and that the "elastic stiffness"

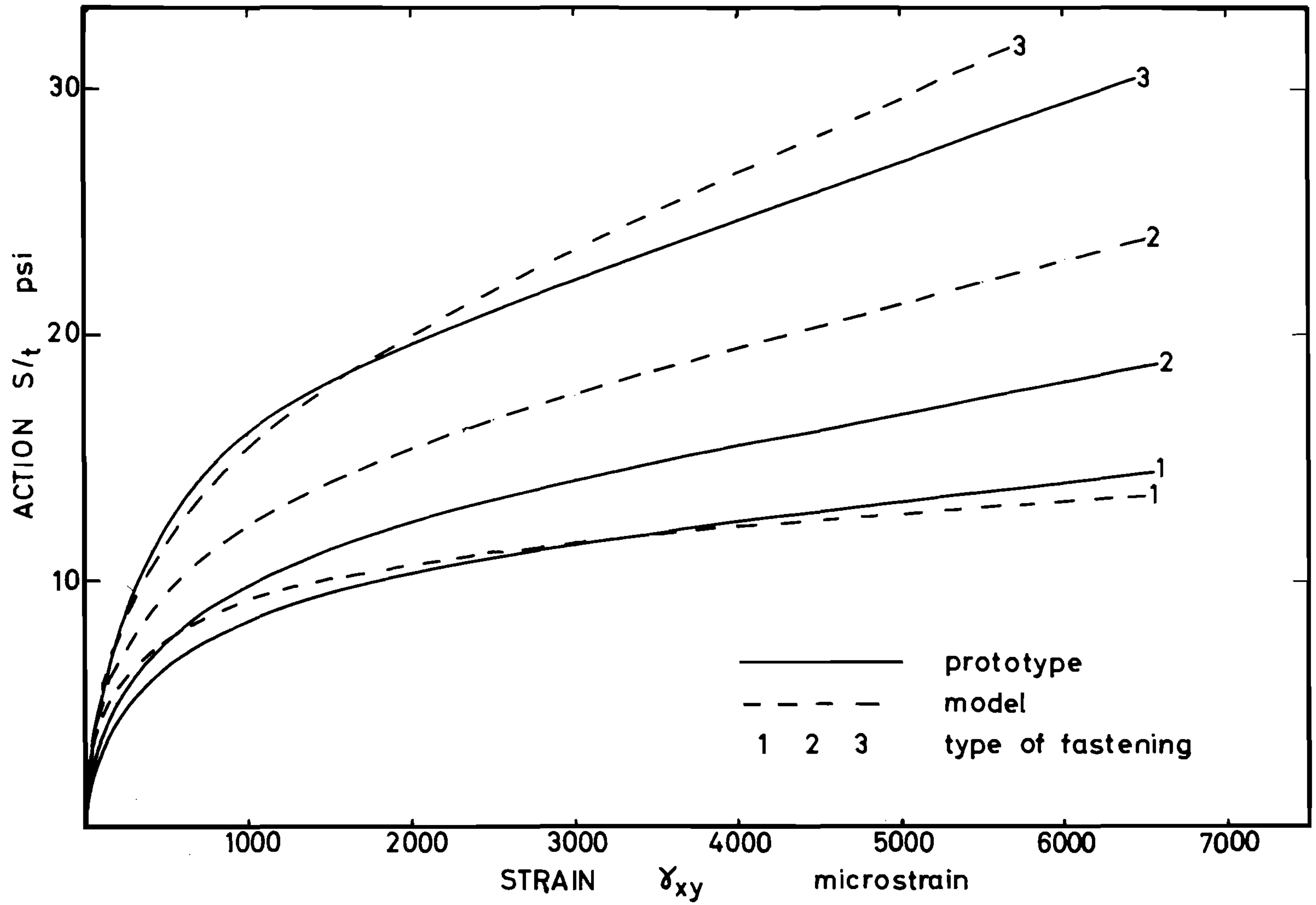


FIG. 6.25. Comparison of curves given by coefficents in table 6.5.

values of the joints bear no relationship to the load cycle behaviour of the elements under action M_1.

The agreement between the values for B_{22} for the nailed elements is good whereas the model glued elements are about 26% stiffer than the prototype. It appears that the extra glue in the model elements caused an outer layer to carry tension perpendicular to the board direction because the observed values of B_{22} are close to the theoretical value. Thus it seems necessary to maintain model similitude to the extent of modelling the weight of glue spread.

Considering the nailed elements in torsion, the model values of B_{33} are up to 40% above the prototype on load cycling and up to 33% below the prototype values on initial loading. The effect of nailing density is seen in figures 5.47 and 6.24 to be different also in that the model elements show a greater increase in stiffness than do the prototype elements with an increase in nailing density. There does not appear to be an obvious reason for the different behaviours of the nailed elements except that, in the case of initial loading, the greater stiffness of the model elements is of the same order as the greater stiffness of the model nailed joints.

The model values of B_{33} for nail-glued elements are 17 to 20% below those for the prototype elements. It is possible that the same effect of the extra glue is present in torsion as it appears to be in the elements under action M_2.

CHAPTER SEVEN

MODEL TIMBER SHELLS

Two model cylindrical timber shells, one nailed and the other nail-glued, were made and tested. Their behaviour is compared with that predicted by Tottenham's[34] design method and with the behaviour of the model elements.

7.1 LITERATURE SURVEY

The only experimental work which appears to have been done on timber shells is that discussed in section 1.2. In these works the prime concern has been with deflections rather than stresses in the shells. This is justified by Keresztesy's[8] work where he finds that for hyperbolic paraboloids the largest bending stresses are usually about 10 to 20% of permissable stresses. Also Pestman[3] loaded an h.p. shell to 250 lb/sq ft before failure occurred. With an expected working load of 20 to 40 lb/sq ft this represents an adequate factor of safety. The experimenters were probably deterred from measuring strains or calculating stresses from those strains which were measured because "of the variability of the properties of timber and the rapid changes of strain that can accompany changes of humidity of the surrounding atmosphere", Tottenham[5].

As regards shell analysis, many papers have been published in recent years on both the experimental and theoretical behaviour of isotropic shells. Many of the analyses could, no doubt, be modified to analyse orthotropic shells since they usually employ orthogonal sets of axes. However, three papers have dealt specifically with the analysis of orthotropic shells. Ambartsumyan[26] used a general analytical approach in considering laminar shells of positive curvature and any arrangement of laminae. The orthotropic cylindrical shell is considered as a particular case, but, as in a similar study by Shipley and Sherrer[33], edge supports are required which give mathematically desirable edge conditions such as zero moment and zero displacement normal to the membrane. Such edge members are rarely practical as they need to be excessively deep and narrow.

Tottenham[34] has published a design method for orthotropic cylindrical shells which is a modification of his earlier work[35] on isotropic cylindrical shells. The analysis includes a simplification known as the Shorer approximation which assumes that the only significant strains are those of longitudinal extension and transverse bending. He warns however, that the method should not be used for shells which have no boards running at an angle to the longitudinal direction other than in the circumferential direction. This is because of the large shear deformation likely in such shells. This is particularly true for nailed membranes as shown by the shear action - shear strain behaviour of elements in figures 5.38 and 6.14. However, for a nailed cylindrical shell with boards running in a diagonal direction as well as longitudinally and transversely, it is possible that shear deformations, caused by slip between the layers could still be too great to be ignored.

7.2 ANALYSIS OF MODEL SHELLS

Considering the values obtained for A_{33} for nail-glued elements in tables 5.7 and 6.3, these values represent shear moduli which are from

60 to 80% of the values expected for plywood. If these shear modulus values imply shear deformation which are sufficiently small to be ignored, then Tottenham's analysis may be used for nail-glued shells whose boards run only in the longitudinal and transverse directions.

Considering the similarity in values of A_{33} for nailed and nail-glued elements under load cycling, the analysis should also be suitable for nailed shells under load cycling.

Figure 7.1 and table 7.1 give the dimensions and properties of the model shells constructed as described in the following section. The A_{ij} and B_{ij} values are obtained by substituting the respective values for the mean grading modulus of the membrane into the regression equations in tables 6.1 and 6.2

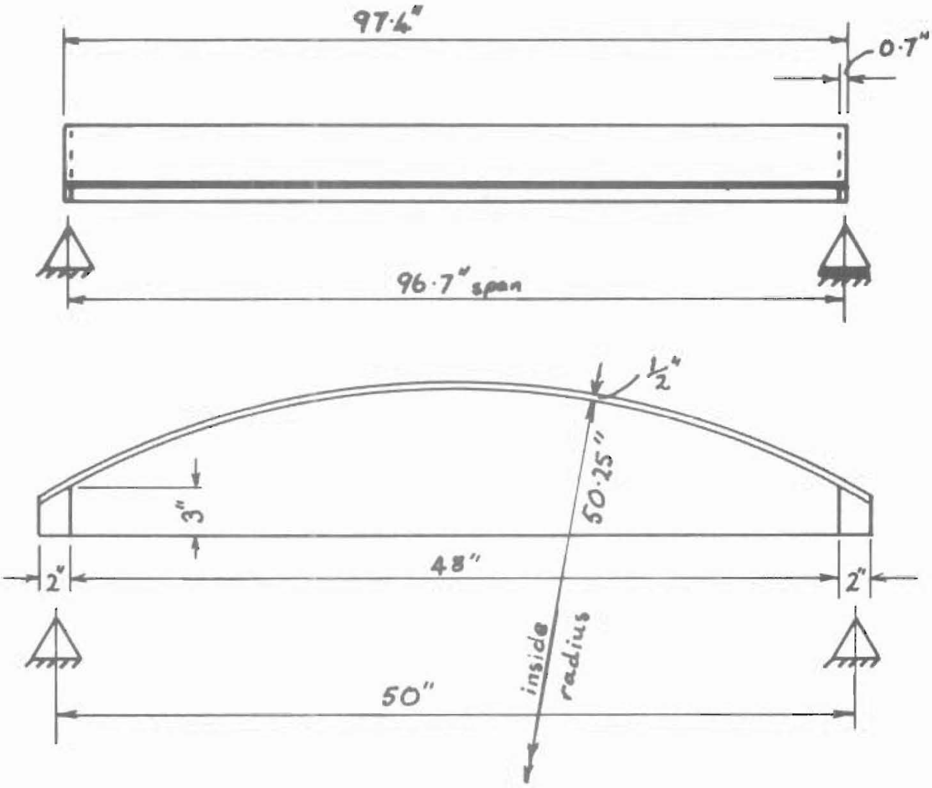


FIG.7.1 Dimensions of model shells.

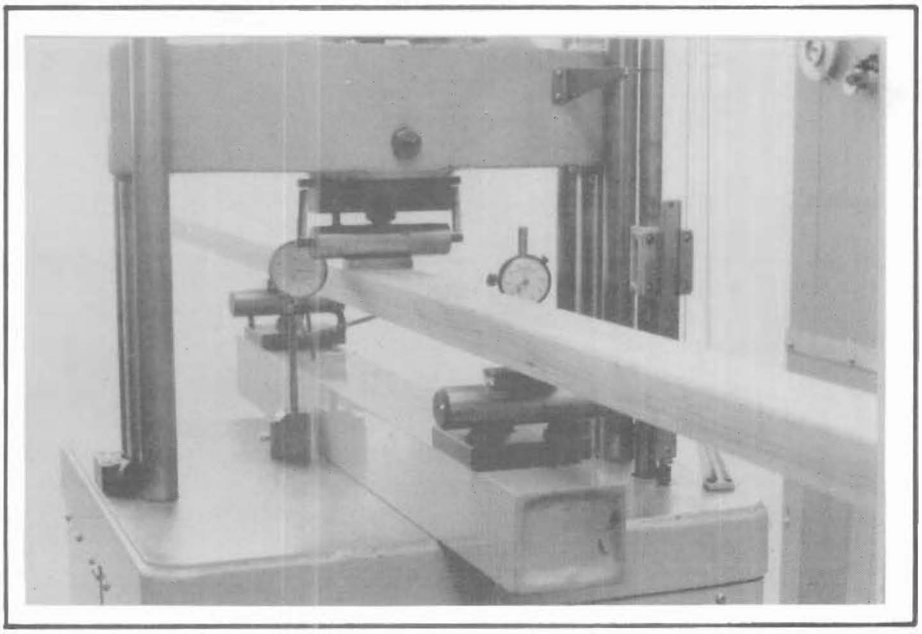


FIG.7.2 Testing edge beams in centre-point bending.

TABLE 7.1 Properties of components of model shells

	SHELL 1	SHELL 2
Fastening of membrane	0.03 lb sq ft/glueline urea formaldehyde glue + model nails in pattern 2	Model nails in pattern 2 with glue at edges
Mean grading modulus of boards in membrane	1.170×10^6 psi	1.157×10^6 psi
Moisture content at test	10.8%	10.8%
Mean M.o.E in compr.// to grain of edge beams	1.785×10^6 psi	1.570×10^6 psi
A_{ij} terms - load cycle	$\begin{bmatrix} 1.179 & -.141 & . \\ -.136 & 2.078 & . \\ . & . & 13.64 \end{bmatrix}$	$\begin{bmatrix} 1.261 & -.123 & . \\ -.217 & 2.350 & . \\ . & . & 19.42 \end{bmatrix}$
B_{ij} terms - load cycle	$\begin{bmatrix} 0.760 & . & . \\ . & 10.13 & . \\ . & . & 7.45 \end{bmatrix}$	$\begin{bmatrix} 1.966 & . & . \\ . & 12.53 & . \\ . & . & 15.77 \end{bmatrix}$
A_{ij} terms - initial loading	$\begin{bmatrix} 1.193 & -.174 & . \\ -.160 & 2.105 & . \\ . & . & 14.33 \end{bmatrix}$	[Not considered due to non-linear nature of shear action - shear strain curve on initial loading of nailed elements]
B_{ij} terms - initial loading	$\begin{bmatrix} 0.774 & . & . \\ . & 10.60 & . \\ . & . & 8.36 \end{bmatrix}$	

Equivalent longitudinal and transverse thicknesses of the membrane are derived from equations [7.1] for the purposes of analysis.

$$\left.\begin{aligned} Et_1 &= t/A_{22} \\ Et_2^3/12 &= t^3/12\,B_{11} \end{aligned}\right\} \qquad \ldots\ldots\ldots\ldots \qquad [7.1]$$

where E = grading modulus of membrane

t_1 = equivalent longitudinal thickness

t_2 = equivalent transverse thikcness

t = actual thickness (0.5 in.)

To allow for the differing moduli of the membrane and edge beams in each shell, the section properties A and I of the edge beams were multiplied by the ratio E_e/E where E_e is the modulus of elasticity in compression parallel to the grain of the edge beams.

Tottenham's method assumes uniformly distributed vertical load whereas the models were tested under uniformly distributed radial load. The following alterations were made to various expressions in Tottenham's method to analyse the radial load case:

Reactions at the edge of the membrane

$V^m = gR \sin \phi \cos \phi$ became $V^m = gR \sin \phi$,

$H^m = gR \cos^2 \phi$ " $H^m = gR \cos \phi$,

$\frac{dS^m}{dx} = 2g \sin \phi$ " $\frac{dS^m}{dx} = 0$,

Displacements at the edge of the membrane

$\delta_A^m = 4g(a \cos^2 \phi + 4 + 2/a)/\ d$

became $= 4ga \cos^2 \phi /\ d$,

$\delta_c^m = M2g \cos \phi / dR$

became $= 0$, where the symbols are those used by Tottenham.(34), otherwise the expressions remained the same. The calculated vertical deflections of the edge beams at midspan are compared with the observed deflections in table 7.2.

TABLE 7.2 Calculated and observed edge beam deflections at midspan caused by 20 lb/sq ft radial load

	SHELL 1		SHELL 2
	LOAD CYCLE (in.)	INITIAL LOAD (in.)	LOAD CYCLE (in.)
Calculated assuming vertical load (a)	.0256	.0257	.0250
" " radial " (b)	.0267	.0279	.0300
Observed deflections (c)	.0458	.0510	.0682
Ratio (c):(b)	1.72:1	1.83:1	2.28:1

The calculated deflections assuming radial load are also compared with the experimental results in figure 7.12.

Tottenham's analysis does not enable the deflections of the membrane to be calculated directly.

7.3 EXPERIMENTAL INVESTIGATION

7.3.1 Construction of Models

A sufficient quantity of model boards were sawn from the prototype as described in section 2.3. These were made up into 100 inch and 56 inch lengths, joining where necessary by means of 45° scarf joints and epoxy adhesive. Their grading modulus was measured at 2 ft intervals as described in section 2.3. The preparation of the boards as well as the construction and testing of the shells was carried out in a room controlled to mean atmospheric conditions of $68^{\circ}F$ and 61% r.h. which gave an equilibrium moisture content of 10.8%.

Glue laminated edge beams were made to the dimensions shown in figure 7.1 by a local manufacturer. These were conditioned in the testing room for two weeks then tested under centre point bending as shown in figure 7.2 in order to estimate their modulus of elasticity as tabulated in table 7.1.

Steel formwork was already available and was set up on the reaction frame shown in figure 7.10. This formwork was a $\frac{1}{4}$ inch thick steel plate rolled to an outside radius of 49.75 in. with stiffening diaphragms welded on the underside. A $\frac{1}{2}$ in. thick sheet of expanded polystyrene was fastened to the formwork to receive the points of the model nails. End diaphragms were cut from 0.7 in. thick plywood and placed, with the edge beams, around the formwork. The diaphragms were fastened to the edge beams with epoxy resin adhesive and screws.

Figures 7.3 and 7.4 show the construction of the nail-glued shell during the placement of the middle and top layers respectively. Various devices were developed to hold the boards in place and to apply a cramping force of 4 lb/in., the same as in the model elements. Each board in the middle and top layers of the nail-glued shell was spread with a measured quantity of glue and nailed in place. The rate of glue spread was 0.03 lb/sq ft/glueline, same as in the model elements. In the nailed shell however, all the boards were positioned, cramped and the nailing pattern drawn before the nails were driven. Also, in the nailed-shell, glue was spread between the edge members and the membrane and within the membrane directly over those edge members.

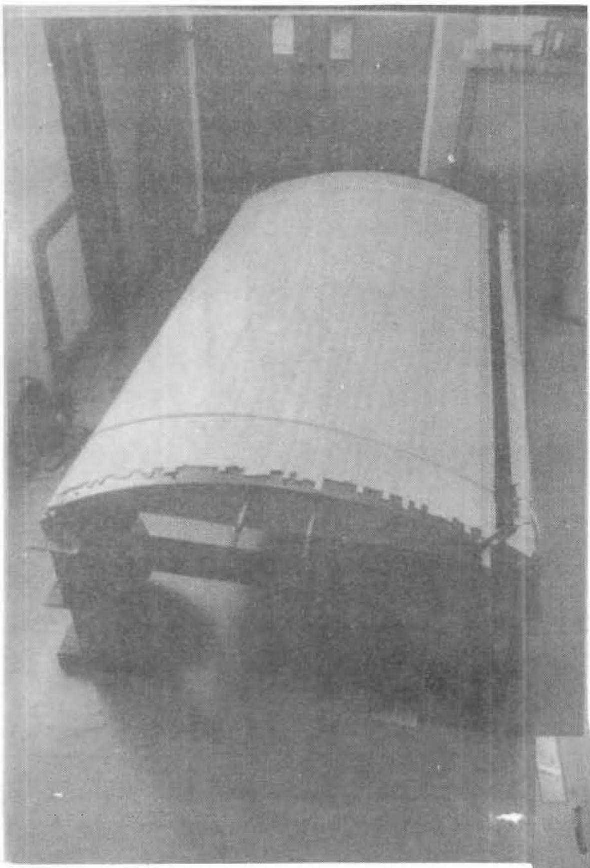


FIG. 7.3. Nail-glued shell during placement of middle layer of boards.

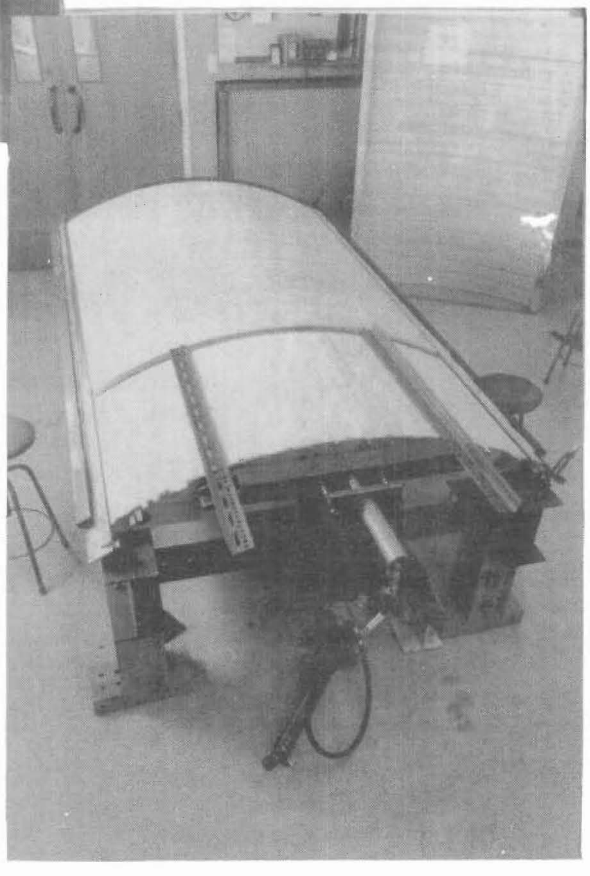


FIG. 7.4 Nail-glued shell during placement of top layer of boards.

When complete the projecting board ends were trimmed and the shell lifted off the formwork.

7.3.2 Testing

The formwork was removed from the frame and load cells set up at each corner, with two cells at one end on rollers to allow movement longitudinally. Steel bearing plates were fixed to each corner and the shell placed on the load cells and their heights adjusted to give equal reactions. An 8 X 4 ft X 6 in. air bag was placed on the shell and a reaction platform erected over that. Figure 7.5 shows the overall arrangement with the load cells connected to a strain bridge through a switch box and a water manometer connected to the air bag and regulator valves.

Deflections were measured with dial gauges. These were mounted on a frame attached to the reaction frame as shown in figure 7.6. Eyelets were screwed into the membrane and connected to dial gauges by threads. Smooth pieces of aluminium were glued to the edge members and dial gauges bore directly against these.

It was assumed that the air bag applied a uniformly distributed radial load to the shell. As shown in figure 7.7, the loading was increased to 20 lb/sq ft, decreased to zero and then increased until the shells showed some obvious sign of failure. This load of 20 lb/sq ft was assumed to be the design dead plus live load for this type of roof. At each load level all the dial gauges were read and the re-read in reverse sequence to give a check and to overcome some of the effects of creep on the readings.

The nailed shell reached a load of 75 lb/sq ft at which the membrane had flattened at midspan as shown in figure 7.8. Also some

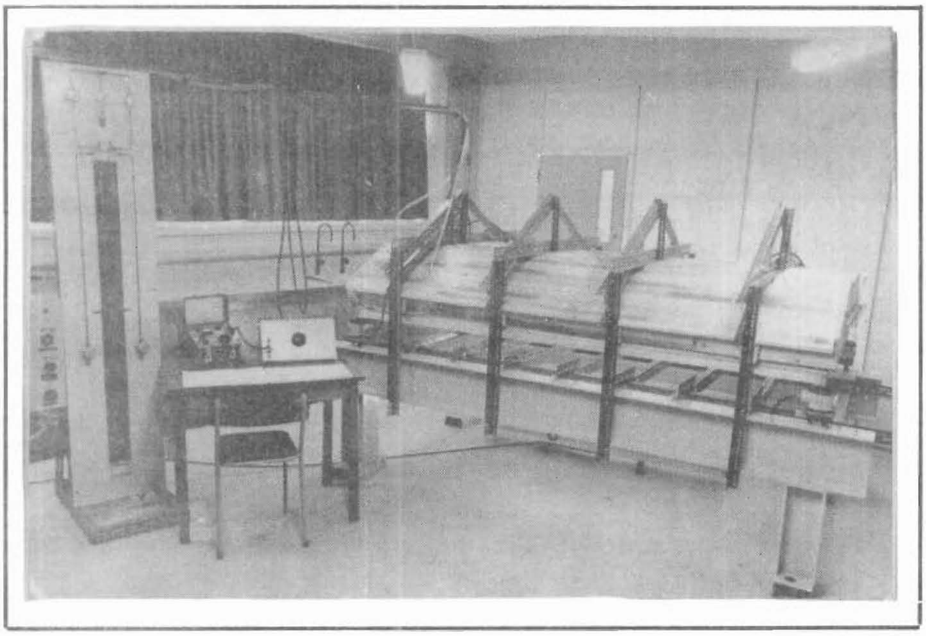


FIG.7.5. Overall arrangement of apparatus for testing model shells.

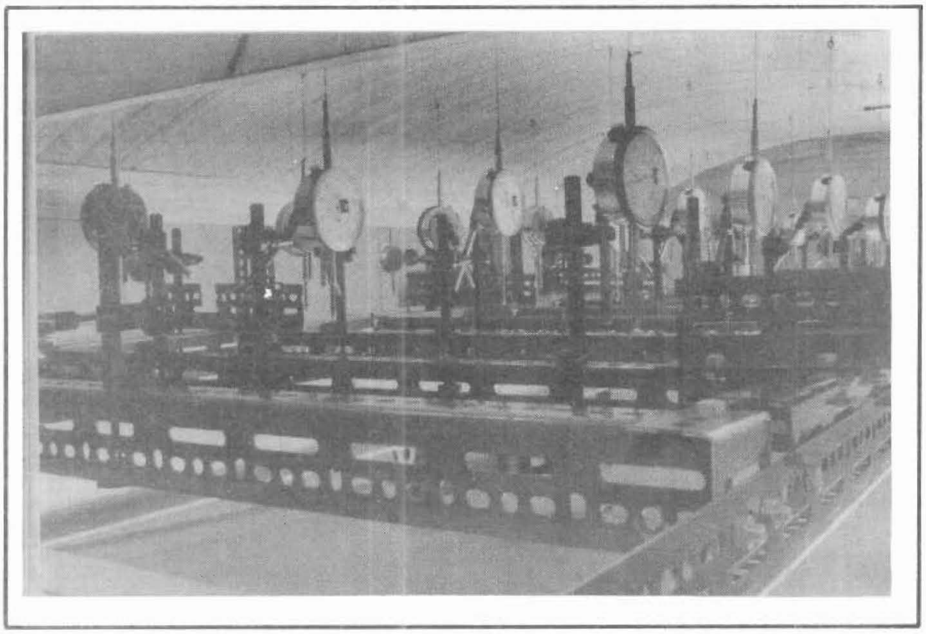


FIG.7.6. Showing dial gauges set up for measuring shell deflections.

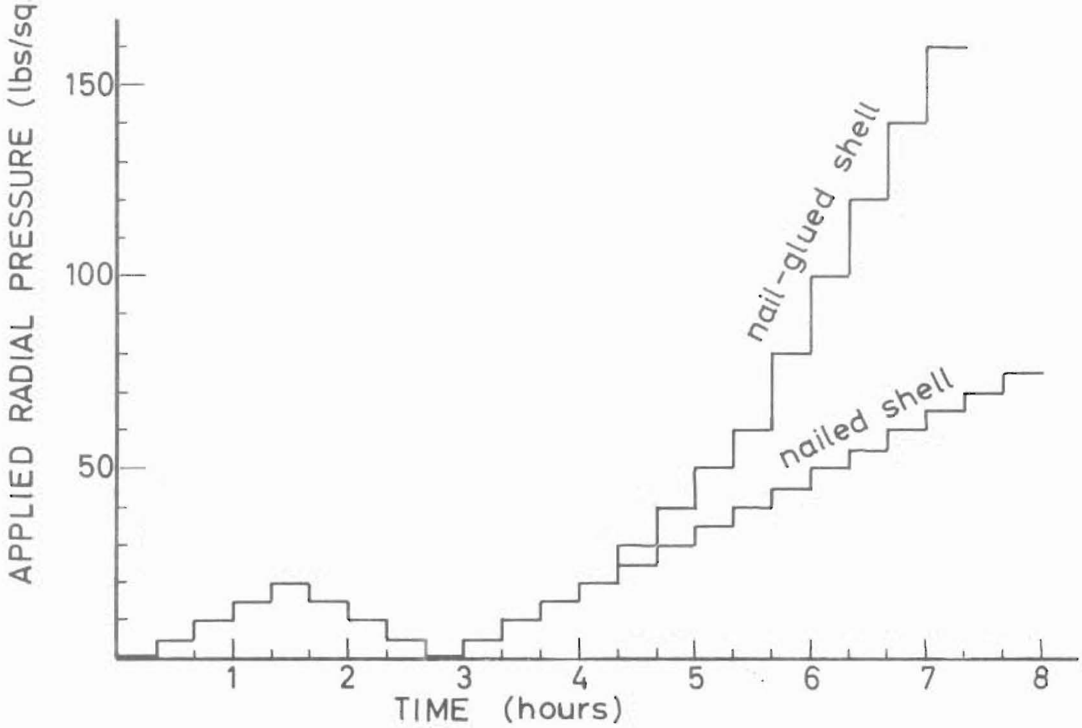


FIG.7.7 Load-time schedules followed in testing shell roofs.

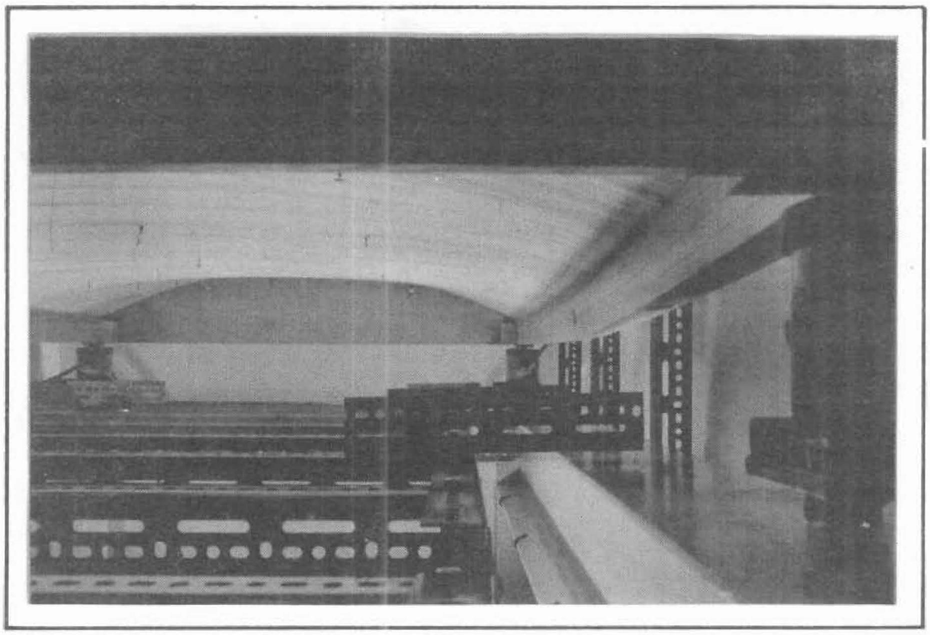


FIG.7.8. Flattened midspan portion of nailed shell at 75 lbs/sq.ft. load viewed from underneath.

boards in the top layer had broken above the midspan point of the edge beam shown in figure 7.8.

The nail-glued shell reached a load of 160 lb/sq ft at which the membrane separated from the edge beam and diaphragm at the corner shown in figure 7.9. On unloading, the glued shell showed no obvious residual deflection while the nailed shell was visibly deformed as shown in figure 7.10.

7.4 RESULTS

The load - deflection data from the tests on the two shells is given in table D.1 in the appendix. Figures 7.11 and 7.12 show the deflections of the centre of the shells and of the edge beams at mid-span plotted against the radial load. Figures 7.13 and 7.14 show the deflection contours at 20 lb/sq ft load and also near failure load for the two shells.

7.5 DISCUSSION

The primary impressions gained from figure 7.12 are that the calculated deflections are about half the observed deflections and that the load-deflection curves are of similar shape to the shear-action-shear strain curves given in figures 5.38 and 6.14 for the elements. This suggests that Tottenham's analysis is unsuitable for shells with this type of membrane because (as he warns) of the large shear deformations likely.

To investigate this point more closely, a flexibility coefficient f was calculated for the load cycle behaviour by means of equation [7.2].

$$f = (\delta_1 - 2\delta_2 + \delta_3)/(P_1 - 2P_2 + P_3) \quad \ldots\ldots\ldots \quad [7.2]$$

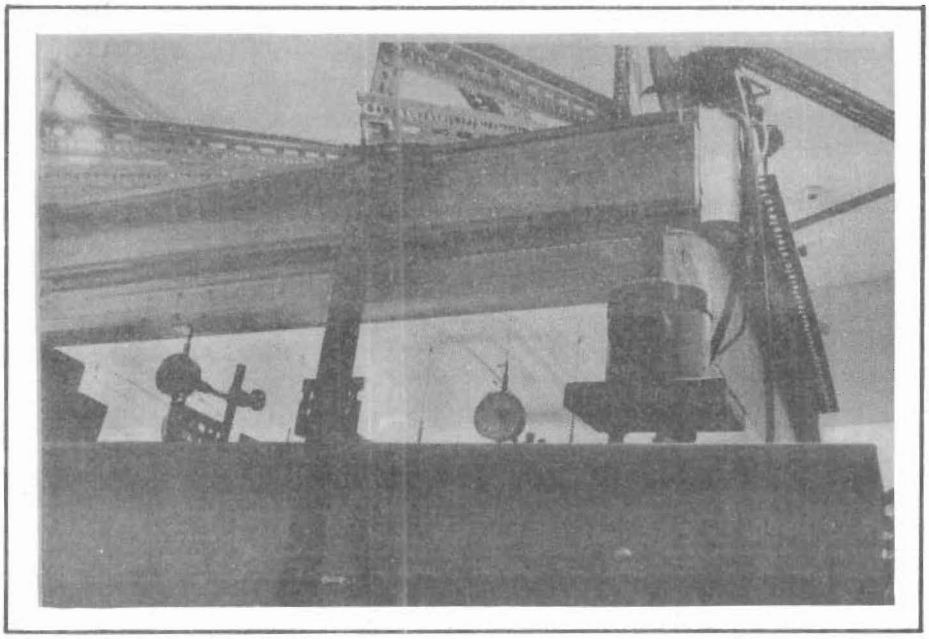


FIG.7.9. Failure of nail-glued shell at 160 lb/sq.ft. between membrane and edge members at one corner.

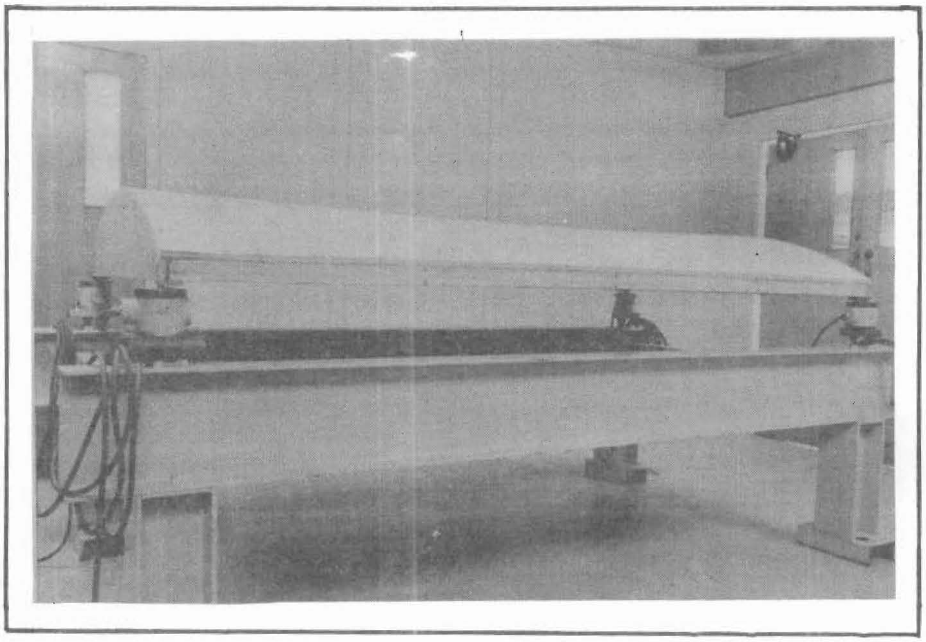


FIG.7.10. Showing deformed shape of nailed shell after removal of air bag, dial gauges and reaction platform.

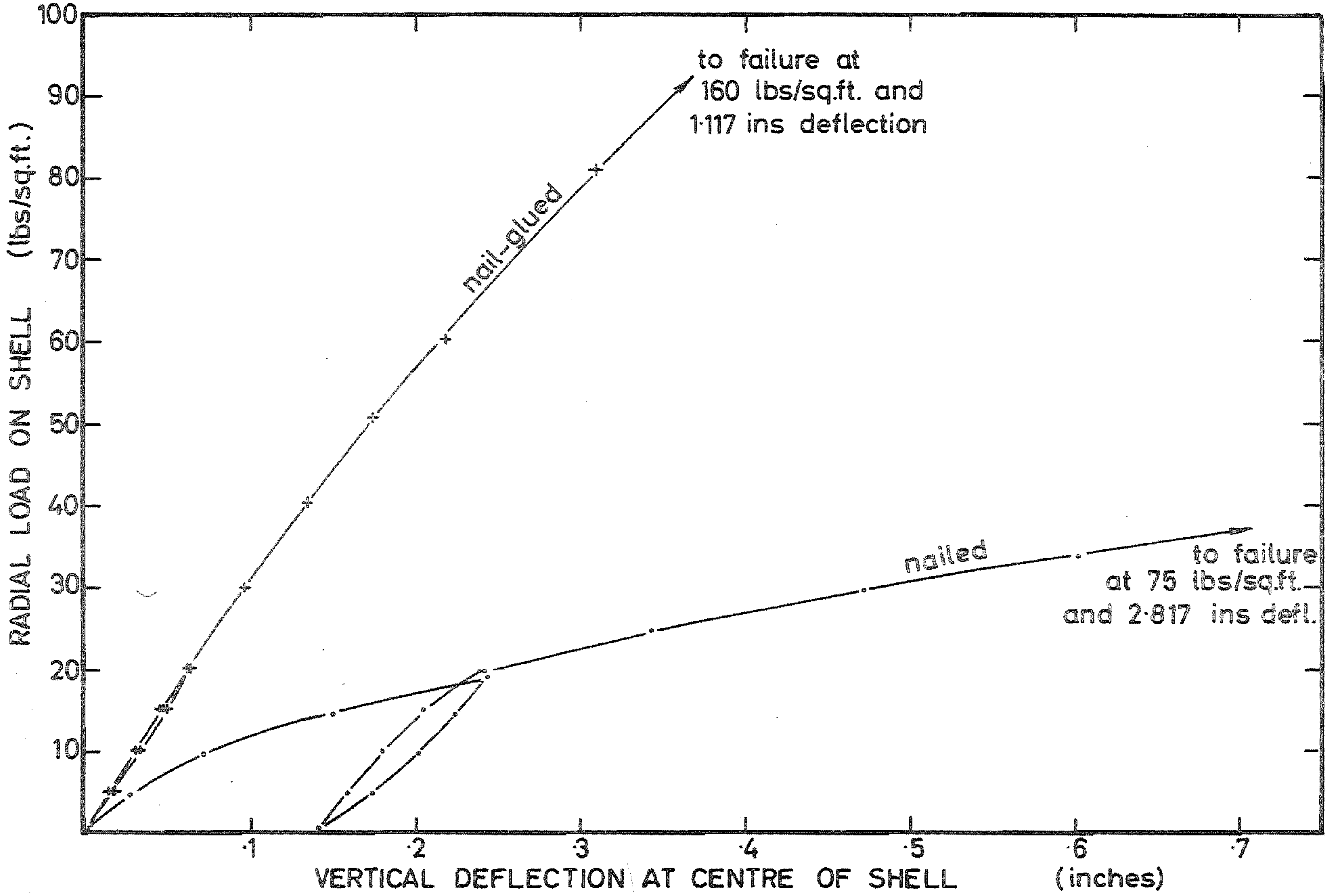


FIG.7.11. Radial load - central deflection curves for model shells.

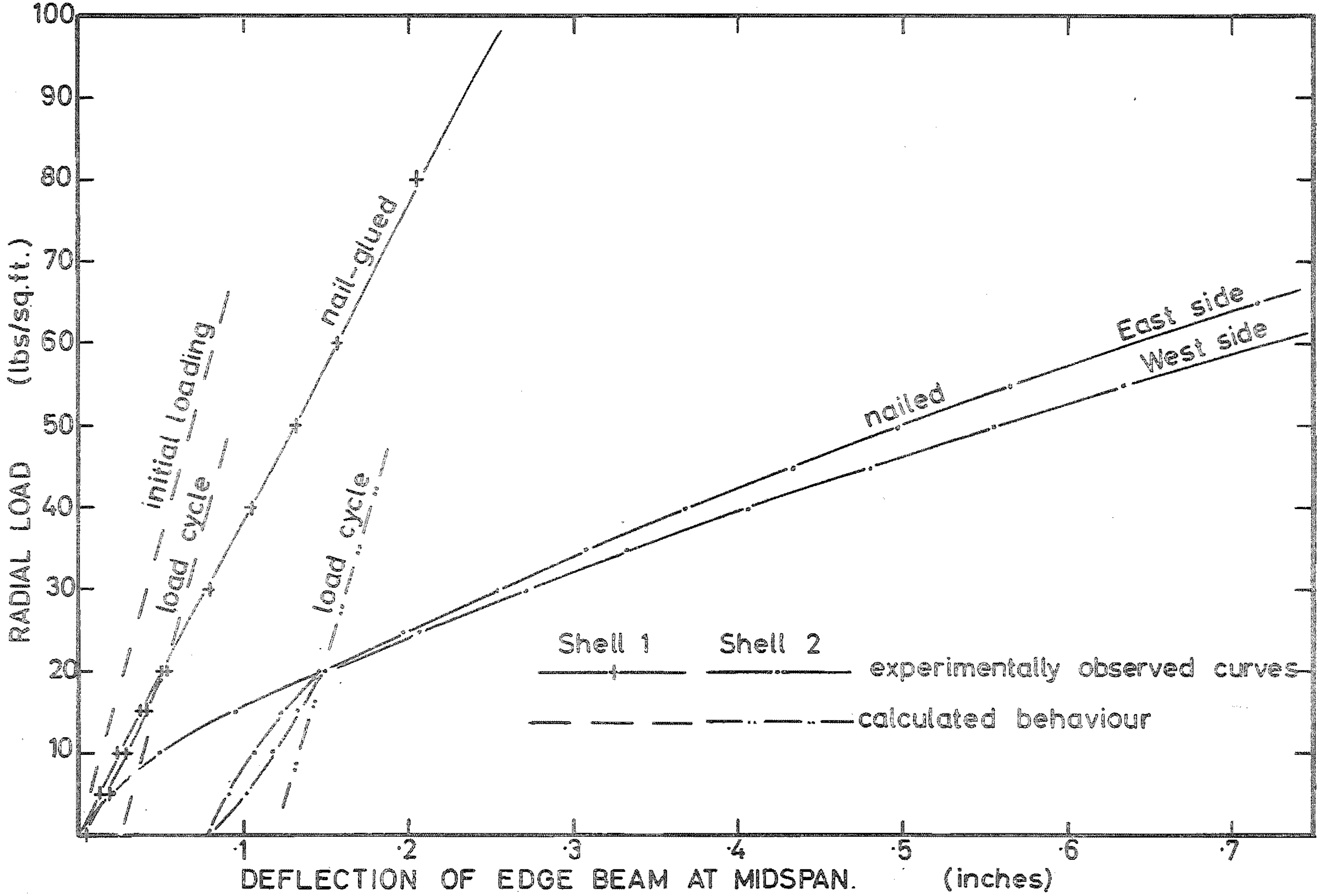
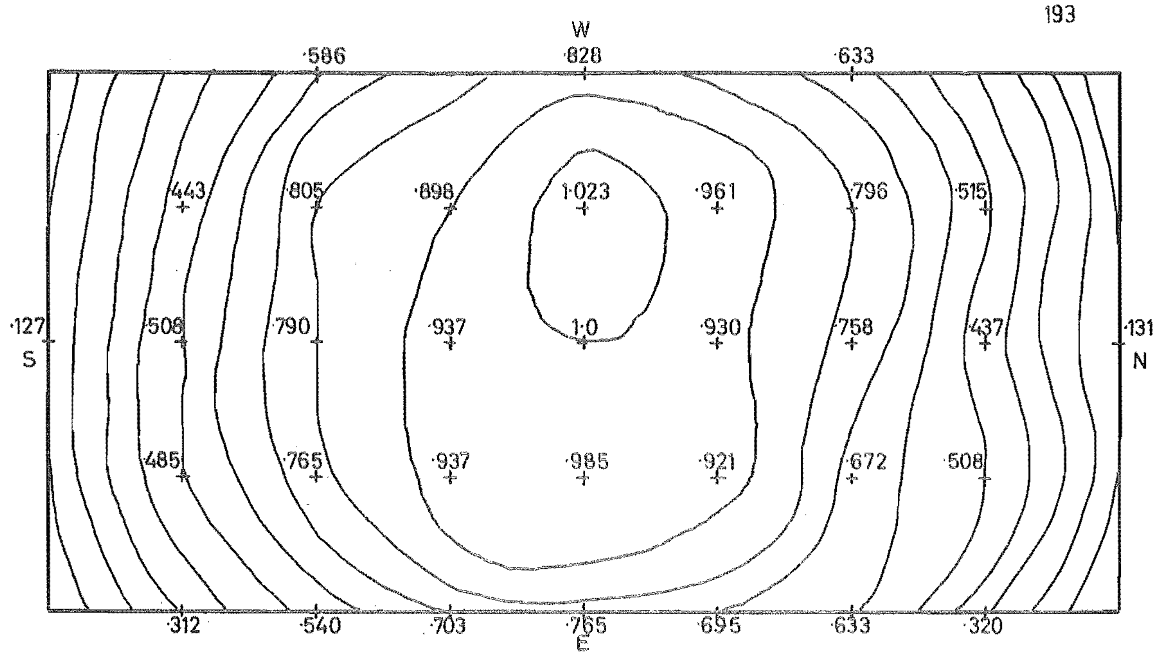
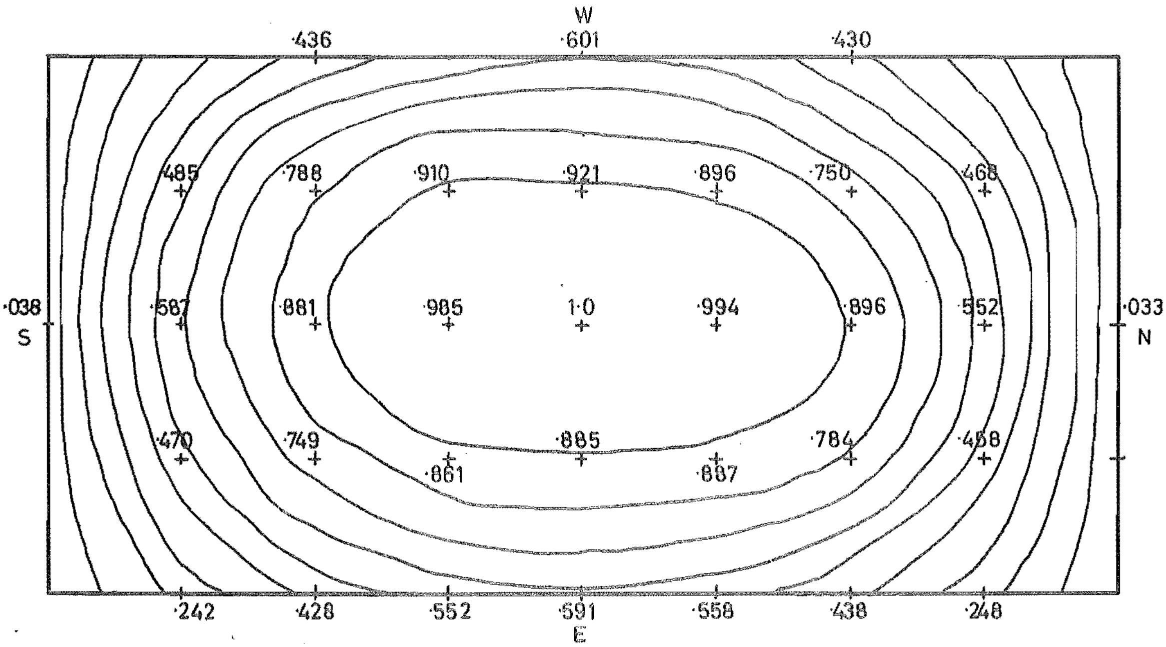


FIG.7.12. Radial load-edge beam deflection curves for model shells.

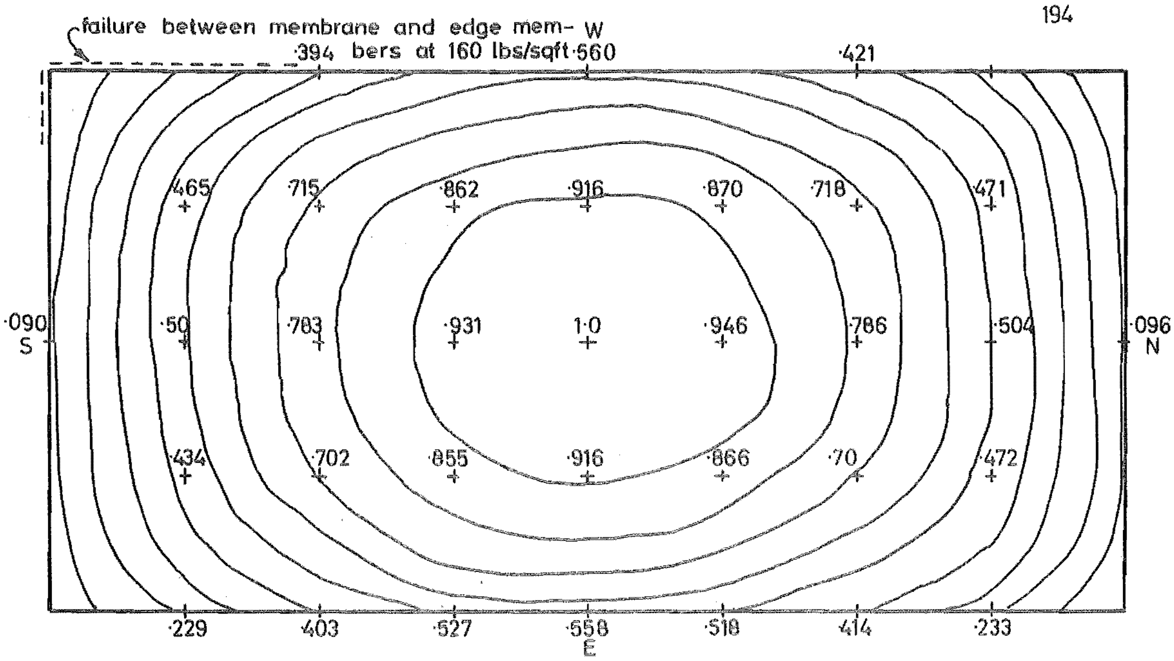


VERTICAL DEFLECTIONS OF SHELL 1 UNDER 20 lbs/sq.ft RADIAL LOAD RELATIVE TO A CENTRAL DEFLECTION OF ·0640 inches.

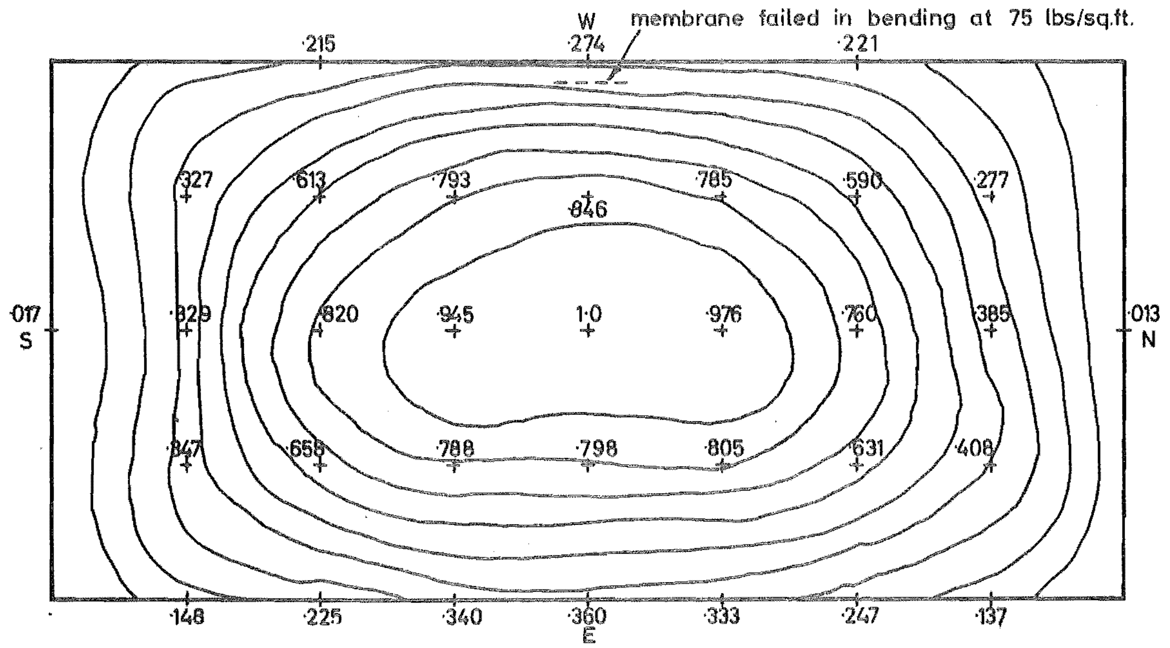


VERTICAL DEFLECTIONS OF SHELL 2 UNDER 20 lbs/sq.ft. RADIAL LOAD RELATIVE TO A CENTRAL DEFLECTION OF ·2445 inches.

FIG. 7.13. DEFLECTION PATTERNS IN SHELLS AT WORKING LOAD.



VERTICAL DEFLECTIONS OF SHELL 1 UNDER 120 lbs/sq.ft. RADIAL LOAD RELATIVE TO THE CENTRAL DEFLECTION OF ·5425 inches.



VERTICAL DEFLECTIONS OF SHELL 2 UNDER 75 lbs/sq.ft. RADIAL LOAD RELATIVE TO THE CENTRAL DEFLECTION OF 2·817 inches.

FIG. 7.14. DEFLECTION PATTERNS IN SHELLS NEAR FAILURE.

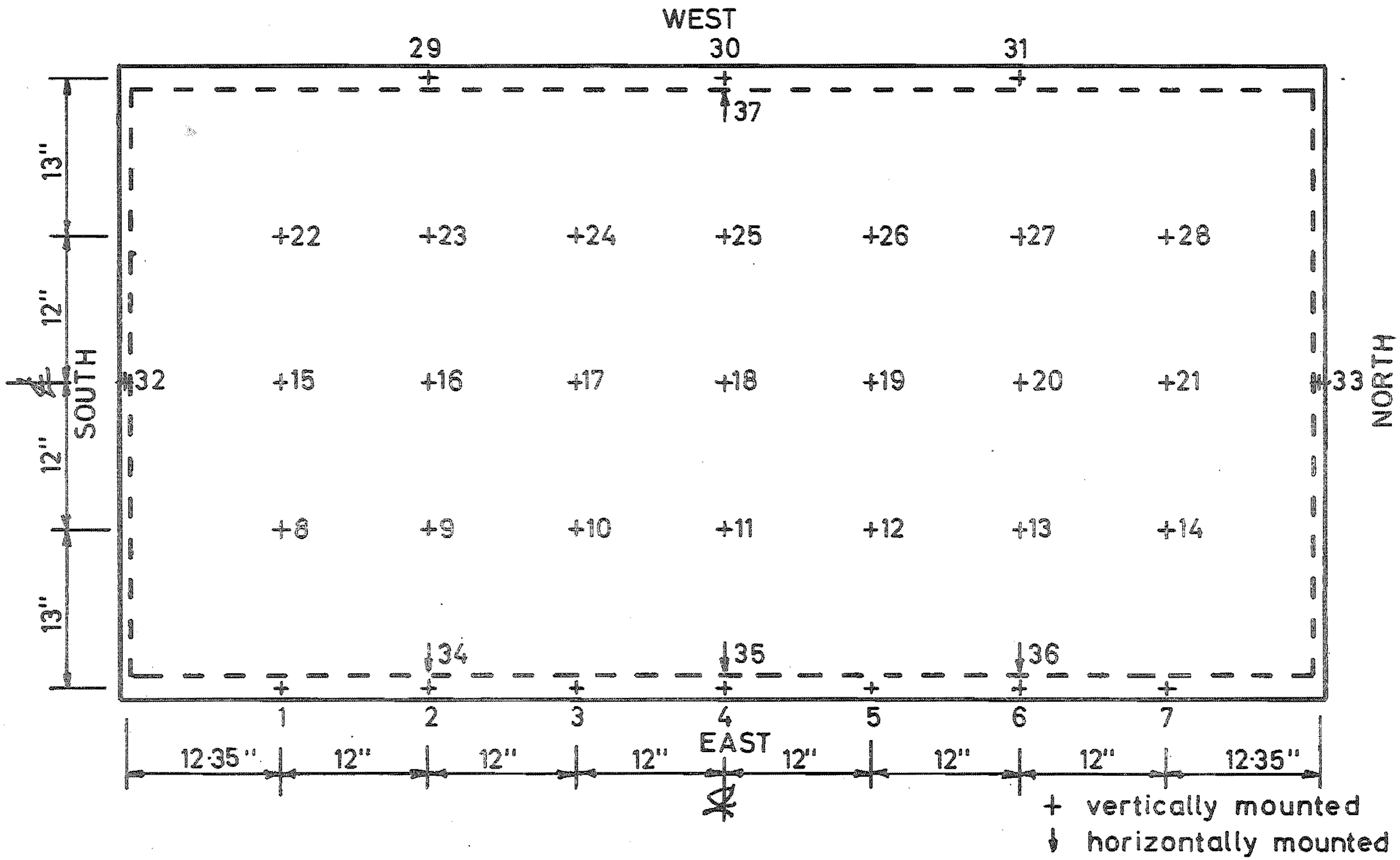


FIG. 7.15. Showing postions of dial gauges in tests on model shells.

where δ = deflection in inches

P = applied pressure in lb/sq ft

and 1, 2, 3 refer to the beginning, minimum and end points of the load cycle.

This flexibility coefficient is compared with the major A_{ij} and B_{ij} values and the moduli values of the membranes and beams in table 7.3

TABLE 7.3 Comparison of the behaviour of the shells and the elements under load cycling

		SHELL 1	SHELL 2	RATIO
f observed at centre	in./lb/sq ft	.00309	.00532	1:1.72
" " " edge	"	.00229	.00341	1:1.49
Difference (centre-edge)	"	.00080	.00191	1:2.39
f calculated at edge	"	.00134	.00150	1:1.12
Modulus E of membrane	X 10^6 psi	1.170	1.157	1.01:1
" " " edge beams	"	1.785	1.570	1.14:1
A_{11}	X 10^{-6} sq in./lb	1.179	1.261	1:1.07
A_{22}	"	2.078	2.350	1:1.13
A_{33}	"	13.64	19.42	1:1.42
B_{11}	"	0.760	1.966	1:2.59
B_{22}	"	10.13	12.53	1:1.24
B_{33}	"	7.45	15.77	1:2.12

Considering the data in table 7.3 it is seen that the calculated edge deflections are in the ratio 1:1.12 which agrees closely with the ratio

1:1.13 between the A_{22} values and the ratio 1.14:1 between the edge beam moduli. Thus it appears that the different transverse flexibilities, as given by the B_{11} values, do not significantly influence the analysis for edge deflection. However, considering the deflections at the shell centres relative to the edges, the ratio of 1:2.39 agrees well with the ratio of 1:2.59 between the B_{11} values. Hence it appears that the bending deformation of the membrane is governed largely by the transverse stiffness, as assumed in Tottenham's analysis. The observed edge deflections are in the ratio 1:1.49 which is greater than the calculated edge deflection ratio of 1:1.12 and is intermediate between the ratios of 1:1.13 and 1:2.59 for A_{22} and B_{11} respectively. This means that either the analysis underestimates the effect of B_{11} on the edge deflections or that another effect such as shear deformation is significant but is ignored by the analysis. This latter point is supported by the fact that the A_{33} values are in the ratio 1:1.42 which is close to 1:1.49 although this ratio can be obtained by a suitable combination of the ratios 1:1.13 and 2.59 for A_{22} and B_{11} respectively and a ratio of 1:1.49 is probably peculiar to shells of the particular dimension, type and construction as tested in this study.

Considering the initial load - deflection behaviour of the shell edges, the relative behaviour of the two shells is similar to the relative behaviours of the nail-glued and nailed elements under actions M_1 or H as shown in figures 6.18 and 6.20 as well as under action S as mentioned earlier. Mathematical comparison of the behaviours is difficult because of the non-linear behaviour of the nailed shell and nailed elements. However, table 7.4 shows the ratios between the shell deflections at several load levels as compared with the A_{ij} and B_{ij} values for initial loading.

TABLE 7.4 Comparison of the behaviour of the shells and the elements under initial loading

		SHELL EDGE DEFLECTION AT LOAD OF:				
		10	20	30	40	lb/sq ft
Shell 1	in.	.0238	.0510	.0810	.1068	
Shell 2	"	.0500	.1458	.2633	.3870	
Ratio		1:2.10	1:2.86	1:3.25	1:3.62	
		SHELL CENTRE DEFLECTION AT LOAD OF:				
		10	20	30	40	lb/sq ft
Shell 1	in.	.0305	.0640	.0974	.1347	
Shell 2	"	.0760	.2405	.4817	.7797	
Ratio		1:2.49	1:3.76	1:4.95	1:5.79	
		CENTRE DEFLECTION-EDGE DEFLECTION				
		10	20	30	40	lb/sq ft
Shell 1	in.	.0067	.0130	.0164	.0279	
Shell 2	"	.0260	.0947	.2184	.3927	
Ratio		1:3.88	1:7.28	1:13.32	1:14.08	
		ELASTIC CONSTANTS OF ELEMENTS				
		A_{11}	A_{22}	B_{11}	B_{22}	B_{33}
Shell 1	X 10^{-6}sq in./lb	1.193	2.105	0.774	10.61	8.36
Shell 2	"	1.279	2.549	2.481	13.84	28.42
Ratio		1:1.07	1:1.21	1:3.21	1:1.30	1:3.40
		SHEAR STRAIN AT SHEAR ACTIONS OF:				
		3.6	7.2	10.8	14.4	lb/in.
Shell 1	microstrain	40	120	210	305	
Shell 2	"	300	1950	5600	11000	
Ratio		1:7.5	1:16.2	1:26.7	1:36.0	

The four particular values of shear action S chosen in table 7.4 are the mean values existing in the membrane at load levels of 10, 20, 30, and 40 lb/sq ft respectively, according to Tottenham's analysis modified for radial load.

Table 7.4 shows that the ratios of the shell edge and centre deflections at an estimated design load of 20 lb/sq ft correspond most closely to the ratios of the B_{11} and B_{33} values. Considering the relative behaviours of the nailed and nail-glued elements at various levels of shear action, and the relative behaviours of the shells at various load levels, similar trends are seen but the correspondence is not very conclusive. If different levels of shear action corresponding to the various load levels are considered however, the shell edge deflection ratios would correspond to shear strain ratios at about one eighth of the mean shear action levels; the shell centre deflection ratios would correspond to the shear strain ratios at about $\frac{1}{4}$ the mean shear action levels; and the shell centre-edge deflection ratios would correspond to the shear strain ratios at about $\frac{1}{2}$ the mean shear action levels.

The differences between the shell centre and shell edge deflections are included in tables 7.3 and 7.4 because of work by Barron[6] who, in comparing his 1/15th scale glued balsawood model conoid with Booth's[4] $\frac{1}{2}$ scale redwood model conoid, found that their behaviours corresponded well if the deflections of the edge members and the deflections of the membranes were considered separately. The edge members of the conoids, were glued laminated bowstring trusses and small timber beams served as representative elements. The membranes were built up from boards and panels, which, in Booth's study, measured 7 ft by 4 ft, served as representative elements. A scale factor derived from flexural tests on the small wooden beams corresponded well at design load with the observed relative deflections of the edge members of the two conoids. In considering the membrane, the difference between the deflections of the membrane and of the edge members was calculated for each conoid. The deflections of the membranes, thus calculated, corresponded well with the deflections of the built up panels when these were tested in flexure.

If similar relationships existed between the two shells tested in this study then the ratio of 2.39 in table 7.2 would correspond to the ratio of 2.59 between the B_{11} values and the ratio of 1.49 between the edge deflections would correspond to the ratio of 1.14 between the E values of the edge beams. There is perhaps some degree of correspondence here but the discrepancies between the respective ratios are of the order of 8% to 23%. For initial loading a similar relationship does not appear to exist. Considering the different structural actions of the conoid and cylindrical shells, in that in the conoid membrane the bending stresses will be higher relative to the membrane stresses than will be the case in the cylindrical shell membrane, then it is hardly likely that the relationships that Barron found should apply to the shells tested in this study.

It appears that the relative behaviours of the nail-glued and nailed shells correspond best to the relative behaviours of the nail-glued and nailed elements tested in shear when suitable comparative levels of load on the shells and shear action on the elements are chosen.

CHAPTER EIGHT

CONCLUSIONS

The objective of this study was to investigate the effects the type of fastening and scaling had on the properties of a timber shell membrane. This included the effect of the type of fastening on the behaviour of model cylindrical shells. The programme of work as set out in section 1.3 was not followed exactly in that the index parameter (grading modulus) was first determined and then used to select material for the subsequent work. Conclusions drawn from the various aspects of the work are:

8.1 GRADING MODULUS

The large inherent variability of timber was demonstrated by the determination of this property. A skewed frequency distribution of all grading modulus measurements was obtained but, when measurements on material containing visible defects were excluded, a nearly symmetrical distribution was obtained. The effect of defects in prototype boards is simply allowed for by using this property as an index parameter.

8.2 PROPERTIES OF RADIATA PINE

Highly significant correlations with grading modulus were obtained for all the 2 cm standard clear specimen properties determined except the proportional limit stress in compression parallel to the grain. The correlation with maximum shear stress parallel to the grain was also somewhat low but still significant at the 1% level of probability. These highly significant correlations together with the large range in grading modulus values means that material representative of that from most sources may be selected from material from a single source.

Material used was low in density and stiffness but was otherwise comparable with radiata pine from other sources.

8.3 FASTENING PROPERTIES

The load-slip behaviour of the nailed joints was difficult to characterise and little correlation with grading modulus was found. In view of the large number of nails normally used in a nailed structure such as a shell, it is probably sufficient to use the mean load-slip curve of the nailed joints in calculating or comparing the performance of a nailed structure. The expression fitted to the load-slip data for the purpose of characterisation contained four arbitrary constants. Better correlations between the arbitrary constants and grading modulus may have been obtained if an expression with fewer arbitrary constants had been used.

Scale effects are likely to preclude achieving model similitude in nailed joints which are geometrically similar to the prototype joints. The search for model similitude must be based on some chosen property of the joint. If this property is the load-slip behaviour then attention should be confined to comparatively small slips.

8.4 PROTOTYPE SHELL ELEMENTS

Strain measurements on the surface of boarded elements must be corrected for the effects of slip between adjacent boards in each layer: this may be done simply by measuring the displacements between points lying on the centrelines of boards.

The elastic constants A_{11} and A_{22} for the type of membrane studied may be calculated accurately from plywood theory regardless of the type of the type of fastening. For nail-glued membranes all the A_{ij} and B_{ij} constants may be satisfactorily calculated from plywood theory except for A_{33} and B_{22} in which the membrane was approximately 50% more flexible than expected.

Nailed membranes of the type studied can be made as stiff as nail-glued elements if sufficient nails are used, except when the elements are loaded in shear or torsion. In the case of shear, the nailed membrane requires layers of boards running at angles other than 90° to gain equivalent stiffness and in the case of torsion the nailing density required would be impracticable.

The need remains for a suitable theory to calculate the behaviour in shear of nailed elements of the type studied since the theory developed was found to be inadequate. However it is unlikely that nailed membranes of this type would be used to resist shear because of their low inherent stiffness except under very low stresses when it appears that friction carries the major portion of the load. Also the theory developed to calculate the behaviour of nailed elements in torsion gave only a lower bound answer, apparently correct where no stress transfer occurs between the layers of boards. Their actual behaviour was intermediate between that calculated and the upper bound behaviour as calculated from the plywood theory.

8.5 MODEL SHELL ELEMENTS

Reasonably accurate modelling of the properties of the prototype elements is obtained provided the properties of the timber and the fastening are accurately simulated. For nail-glued elements it appears to be necessary to maintain similitude even to the weight of glue spread per unit area.

That no scale effects are apparent in the modelling of the timber itself is indicated by the excellent agreement between the A_{11} values for the prototype and model elements. It is possible that scale effects are present in the properties of the elements but are allowed for by being present in the grading modulus also.

8.6 MODEL SHELLS

The calculated deflections of the model shells were about one half of those observed. It is possible that shear deformations were responsible for the greater observed deflections.

The relative behaviours of the two shells under load cycling were very similar to the relative behaviours of the nail-glued and nailed elements under load cycling in shear. For initial loading, however, the relative behaviour of the two shells was not typified by the relative behaviour of the elements under any of the various types of stress except that, under shear stress, if suitable levels of load on the shells and shear stress on the elements were chosen for comparison of behaviour, then the relative behaviour of the shells was typified by the relative behaviour of the elements in shear.

8.7 SUGGESTIONS FOR FURTHER WORK

The experimental techniques developed in this study should be suitable for studying elements with other arrangements of boards. It appears that experimental methods will be required to determine accurately the properties of nailed shell elements, particularly as the nailed fastening shows non-linear behaviour: the nailed elements in particular appear difficult to analyse.

It should be possible to develop a computer program to analyse shell structures, which takes into account all the shell element properties and not just constants A_{22} and B_{11} as does Tottenham's analysis. With such a program, and if the properties of elements with different board arrangements were found, then it would be possible to determine the most suitable type of membrane for the different types of shell and to determine the limiting dimensions for shells with nailed membranes.

Scale models of nailed membranes much smaller than those in this study are not practicable because of the difficulty of driving small fasteners. It may be possible to overcome this by using a flexible adhesive to simulate the properties of nailed fastenings. This would enable the study of mechanically fastened timber shells by means of smaller, and therefore cheaper, models.

SUMMARY

This study investigated the effects of the type of fastening and of scaling on the properties of a shell membrane by using tests on shell elements. The study was extended to include the effect the type of fastening had on the deflections of model cylindrical shells.

The shell membrane studied was a three-layer type made of ex 4 X 1 in. T & G radiata pine boards, the centre layer running at right angles to the outer layers. The grading modulus (which was the stiffness of the boards measured under central point loading over a 3 ft span) was used as an index parameter in the succeeding work. Standard clear specimens 2 X 2 cm cross section were selected and tested in static bending, compression perpendicular and parallel to the grain and in shear parallel to the grain. The several properties had highly significant correlations with grading modulus.

Tests were made on nail-glued and on nailed joints to characterise the properties of fasteners. The expression

$$P = (A\delta + B)(1 - e^{C\delta})^{D}$$

was fitted to the load-slip data of the nailed joints where

P is the load

δ is the slip

and A, B, C and D are arbitrary constants found to give a least squares best fit. Little correlation was found between the grading modulus and these arbitrary constants. Model joints to 1/5 scale were tested and their behaviour studied as for prototype joints.

Prototype and 1/5 scale model elements of the shell membrane were built and tested in compression, shear, bending and torsion. Strains

were observed in the compression and shear tests and curvature in the bending and torsion tests. Agreement between model and prototype element behaviour was generally good. Where reasonably linear behaviour was found, elastic constants were calculated. The behaviour of the nailed elements in shear was non-linear, similar to the load-slip behaviour of the nailed joints. The expression

$$S = (A\gamma_{xy} + B)(1 - e^{C\gamma_{xy}})^D$$

was fitted to their shear action-shear strain data

where S is the shear action

γ_{xy} is the shear strain

and A, B, C and D are arbitrary constants.

The type of fastening has little influence on the behaviour of the elements in either compression or in bending in the direction of the centre layer. In these cases the correlation with grading modulus was highly significant. Their behaviour in shear was highly dependent on the type of fastening, but showed little correlation with grading modulus. Their behaviour in torsion and bending in the direction of the outer layers showed some correlation with both type of fastening and the grading modulus.

Two 1/5 scale model cylindrical shells with nail-glued and nailed membranes respectively, were made and tested under uniform radial load. Their deflections were about twice those calculated by an analysis which assumed that the only significant strains were those of longitudinal extension (in the direction of the centre layer) and of transverse bending (in the direction of the outer layers). The effect of the type of fastening on the relative behaviour of the two shells compared most closely with the effect on the relative behaviour of the nail-glued and nailed elements in shear. This suggests the error in the calculated deflections was due to shear deformations which the analysis ignored and that the relative performance of the nail-glued and nailed timber cylindrical shells may be typified by the relative performance of representative elements in shear.

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APPENDIX

TABLE A1 LOAD-DEFORMATION DATA FROM PROTOTYPE NAILED JOINTS

Series I. Load perp., parll., perp. to grain of the three members

Grading Modulus ($\times 10^6$ psi)	Initial Slip* (in.)	Load (lb) and deformation (in.) at each increment														
0.497	0.0105	133. 0.0138	266. 0.0195	399. 0.0260	532. 0.0343	399. 0.0340	266. 0.0320	133. 0.0289	266. 0.0303	399. 0.0330	532. 0.0361	665. 0.0457	798. 0.0619	931. 0.0849	1064. 0.1130	1914. 0.5000
0.671	0.0024	141. 0.0051	282. 0.0087	422. 0.0149	563. 0.0253	422. 0.0254	282. 0.0240	141. 0.0216	282. 0.0225	422. 0.0245	563. 0.0273	704. 0.0426	845. 0.0788	986. 0.1344	1126. 0.1974	1581. 0.5000
0.680	0.0050	141. 0.0099	282. 0.0160	424. 0.0242	565. 0.0351	424. 0.0346	282. 0.0330	141. 0.0307	282. 0.0316	424. 0.0335	565. 0.0367	706. 0.0515	847. 0.0810	988. 0.1330	1130 0.1880	1738. 0.5000
0.697	0.0119	142. 0.0168	284. 0.0232	426. 0.0304	568. 0.0423	426. 0.0426	284. 0.0410	142. 0.0380	284. 0.0389	426. 0.0412	568. 0.0446	710. 0.0617	852. 0.0950	994. 0.1557	1136. 0.2170	1527. 0.5000
0.785	0.0185	146. 0.0220	292. 0.0276	438. 0.0354	584. 0.0477	438. 0.0469	292. 0.0450	146. 0.0408	292. 0.0419	438. 0.0450	584. 0.0497	730. 0.0717	876. 0.1245	1022. 0.2067	1168. 0.2860	1452. 0.5000
0.785	0.0078	146. 0.0114	292. 0.0173	438. 0.0259	584. 0.0413	438. 0.0404	292. 0.0385	146. 0.0342	292. 0.0362	438. 0.0390	584. 0.0422	730. 0.0683	876. 0.0870	1022. 0.1090	1168. 0.2040	1340. 0.5000
0.811	0.0025	147. 0.0071	295. 0.0132	442. 0.0210	589. 0.0325	442. 0.0313	295. 0.0286	147. 0.0247	295. 0.0270	442. 0.0301	589. 0.0341	737. 0.0467	884. 0.0740	1031. 0.1124	1178. 0.1642	1612. 0.5000
0.828	0.0035	148. 0.0061	296. 0.0114	444. 0.0222	592. 0.0464	444. 0.0448	296. 0.0428	148. 0.0380	296. 0.0397	444. 0.0428	592. 0.0491	741. 0.1015	889. 0.1765	1042. 0.2570	1185. 0.3480	1355. 0.5000
0.846	0.0130	149. 0.0168	298. 0.0218	447. 0.0298	596. 0.0428	447. 0.0426	298. 0.0409	149. 0.0370	298. 0.0384	447. 0.0409	596. 0.0451	745. 0.0642	893. 0.1100	1042. 0.1685	1191. 0.2430	1430. 0.5000
0.872	0.0096	150. 0.0135	300. 0.0202	450. 0.0290	600. 0.0433	450. 0.0424	300. 0.0400	150. 0.0340	300. 0.0369	450. 0.0405	600. 0.0454	750. 0.0652	901. 0.1075	1051. 0.1715	1201. 0.2465	1588. 0.5000
0.872	0.0055	150. 0.0070	300. 0.0099	450. 0.0139	600. 0.0203	450. 0.0196	300. 0.0183	150. 0.0167	300. 0.0177	450. 0.0190	600. 0.0211	750. 0.0309	901. 0.0519	1051. 0.0918	1201. 0.1573	1757. 0.500
0.872	0.0035	150. 0.0066	300. 0.0117	450. 0.0208	600. 0.0376	450. 0.0368	300. 0.0342	150. 0.0298	300. 0.0318	450. 0.0351	600. 0.0400	750. 0.0702	901. 0.1500	1051. 0.2303	1201. 0.3390	1348. 0.5000
0.881	0.0060	151. 0.0077	301. 0.0109	452. 0.0166	602. 0.0247	452. 0.0239	301. 0.0221	151. 0.0190	301. 0.0204	452. 0.0226	602. 0.0260	753. 0.0366	903. 0.0587	1054. 0.0910	1204. 0.1320	1830. 0.5000
0.881	0.0028	151. 0.0064	301. 0.0112	452. 0.0227	602. 0.0432	452. 0.0420	301. 0.0394	151. 0.0347	301. 0.0371	452. 0.0403	602. 0.0457	753. 0.0842	903. 0.1636	1054. 0.2502	1204. 0.3632	1380. 0.5000
0.881	0.0100	151. 0.0139	301. 0.0190	452. 0.0277	602. 0.0418	452. 0.0408	301. 0.0384	151. 0.0344	301. 0.0360	452. 0.0391	602. 0.0440	753. 0.0675	903. 0.1180	1054. 0.1858	1204. 0.2668	1455. 0.5000
0.915	0.0028	152. 0.0049	304. 0.0089	456. 0.0169	608. 0.0322	456. 0.0314	304. 0.0296	152. 0.0257	304. 0.0268	456. 0.0291	608. 0.0342	761. 0.0648	913. 0.1280	1065. 0.1870	1217. 0.2650	1452. 0.5000
0.915	0.0038	152. 0.0069	304. 0.0108	456. 0.0167	608. 0.0271	456. 0.0264	304. 0.0245	152. 0.0214	304. 0.0227	456. 0.0251	608. 0.0288	761. 0.0429	913. 0.0763	1065. 0.1235	1217. 0.1730	1715. 0.5000
0.942	0.0076	153. 0.0103	307. 0.0146	460. 0.0219	613. 0.0329	460. 0.0321	307. 0.0304	153. 0.0275	307. 0.0289	460. 0.0310	613. 0.0347	767. 0.0518	920. 0.0880	1073. 0.1405	1226. 0.2035	1555. 0.5000
0.942	0.0081	153. 0.0142	307. 0.0224	460. 0.0348	613. 0.0602	460. 0.0596	307. 0.0564	153. 0.0502	307. 0.0526	460. 0.0574	613. 0.0644	767. 0.1145	920. 0.1840	1073. 0.2735	1226. 0.3935	1340. 0.5000
0.976	0.0090	155. 0.0138	310. 0.0194	465. 0.0275	620. 0.0389	465. 0.0380	310. 0.0358	155. 0.0307	310. 0.0329	465. 0.0361	620. 0.0400	775. 0.0592	929. 0.0982	1084. 0.1540	1239. 0.2155	1550. 0.0500
1.003	0.0020	156. 0.0095	312 0.0200	468. 0.0364	624. 0.0617	468. 0.0606	312. 0.0573	156. 0.0502	312. 0.0533	468. 0.0585	624. 0.0647	781. 0.1005	937. 0.1695	1093. 0.2390	1249. 0.3340	1413 0.500
1.037	0.0045	158. 0.0079	315. 0.0121	473. 0.0180	631. 0.0266	473. 0.0257	315. 0.0236	158. 0.0202	315. 0.0218	473. 0.0244	631. 0.0279	789. 0.0412	946. 0.0665	1104. 0.1235	1262. 0.1765	1710. 0.5000
1.046	0.0065	158. 0.0123	316. 0.0193	474. 0.0265	632. 0.0360	474. 0.0349	316. 0.0328	158. 0.0292	316. 0.0309	474. 0.0334	632. 0.0373	791. 0.0532	949. 0.0838	1107. 0.1312	1265. 0.1912	1720. 0.5000
1.064	0.0048	159. 0.0088	318. 0.0134	477. 0.0198	636. 0.0277	477. 0.0268	318. 0.0250	159. 0.0219	318. 0.0232	477. 0.0255	636. 0.0290	795. 0.0390	953. 0.0587	1112. 0.0973	1271. 0.1525	1860. 0.5000
1.072	0.0050	159. 0.0092	319. 0.0138	478. 0.0208	637. 0.0325	478. 0.0318	319. 0.0302	159. 0.0266	319. 0.0277	478. 0.0303	637. 0.0343	797. 0.0562	956. 0.1185	1115. 0.1945	1274. 0.2625	1647. 0.5000
1.037	0.0030	158. 0.0076	315. 0.0138	473. 0.0236	631. 0.0446	473. 0.0441	315. 0.0419	158. 0.0369	315. 0.0385	473. 0.0422	631. 0.0477	789. 0.0838	946. 0.1473	1104. 0.2168	1262. 0.3158	1455. 0.5000

TABLE A1 CONTINUED

Series I, Load perp., parll., perp. to grain of the three members

Grading Modulus ($\times 10^6$ psi)	Initial Slip* (in.)	Load (lb) and deformation (in.) at each increment														
1.046	0.0015	158.	316.	474.	632.	474.	316.	158.	316.	474.	632.	791.	949.	1107.	1265.	1907.
		0.0052	0.0102	0.0161	0.0238	0.0230	0.0216	0.0180	0.0191	0.0216	0.0248	0.0333	0.0508	0.0850	0.1315	0.5000
1.064	0.0	159.	318.	477.	636.	477.	318.	159.	318.	477.	636.	795.	953.	1112.	1271.	1680.
		0.0033	0.0078	0.0142	0.0221	0.0212	0.0198	0.0168	0.0180	0.0201	0.0233	0.0333	0.0520	0.0810	0.1265	0:5000
1.072	0.0010	159.	319.	478.	637.	478.	319.	159.	319.	478.	637.	797.	956.	1115.	1274.	1802.
		0.0087	0.0187	0.0290	0.0412	0.0404	0.0383	0.0331	0.0352	0.0390	0.0428	0.0550	0.0780	0.1220	0.1790	0.5000
1.081	0.0046	160.	319.	479.	639.	479.	319.	160.	319.	479.	639.	799.	958.	1118.	1278.	1558.
		0.0102	0.0177	0.0298	0.0451	0.0442	0.0422	0.0374	0.0394	0.0424	0.0471	0.0675	0.1190	0.1950	0.2930	0.5000
1.081	0.0083	160.	340.	479.	639.	479.	340.	160.	340.	479.	639.	799.	958.	1118.	1278.	1676.
		0.0112	0.0160	0.0219	0.0325	0.0320	0.0301	0.0266	0.0278	0.0302	0.0340	0.0481	0.0755	0.1200	0.1755	0.5000
1.186	0.0110	160.	319.	479.	639.	479.	319.	160.	319.	479.	639.	799.	958.	1118.	1278.	1596.
		0.0148	0.0200	0.0250	0.0354	0.0342	0.0320	0.0284	0.0301	0.0328	0.0367	0.0491	0.0770	0.1200	0.1820	0.5000
1.081	0.0185	160.	319.	479.	639.	479.	319.	160.	319.	479.	639.	799.	958.	1118.	1278.	1581.
		0.0278	0.0360	0.0516	0.0640	0.0633	0.0613	0.0564	0.0579	0.0608	0.0650	0.0778	0.1157	0.1735	0.2400	0.5000
1.203	0.0085	165.	331.	496.	662.	496.	331.	165.	331.	496.	662.	827.	992.	1158.	1345.	1915.
		0.0117	0.0162	0.0220	0.0302	0.0298	0.0282	0.0249	0.0260	0.0281	0.0316	0.0420	0.0636	0.0975	0.1420	0.5000
1.264	0.0	168.	336.	505.	673.	05.	336.	168.	336.	505.	673.	841.	1009.	1177.	1346.	1588.
		0.0080	0.0192	0.0293	0.0427	0.0418	0.0397	0.0350	0.0361	0.0391	0.0431	0.0603	0.1065	0.1785	0.3750	0.5000
1.290	0.0094	169.	339.	508.	678.	508	339.	169.	339.	508.	678.	847.	1016.	1186.	1355.	1990.
		0.0140	0.0191	0.0247	0.0310	0.0308	0.0298	0.0271	0.0280	0.0292	0.0316	0.0383	0.0503	0.0730	0.1080	0:5000
1.299	0.0085	170.	340.	509.	679.	509.	340.	170	340.	509.	679.	849.	1019.	1189.	1358.	1842.
		0.0137	0.0211	0.0287	0.0378	0.0372	0.0356	0.0311	0.0323	0.0351	0.0387	0.0494	0.0735	0.1080	0.1540	0.5000
1.316	0.0083	171.	341.	512.	682.	512.	341.	171.	341.	512.	682.	853.	1024.	1194.	1365.	1864.
		0.0132	0.0191	0.0258	0.0351	0.0342	0.0321	0.0281	0.0297	0.0326	0.0364	0.0485	0.0740	0.1140	0.1590	0.5000
1.325	0.0010	171.	3 2.	513.	684.	513.	342.	171.	342.	513.	684.	855.	1026.	1197.	1368.	1856.
		0.0070	0.0138	0.0217	0.0321	0.0319	0.0299	0.0254	0.0269	0.0298	0.0339	0.0468	0.0718	0.1140	0.1700	0.5000
1.360	0.0045	173.	345.	518.	690.	518.	345.	173.	345.	518.	690.	863.	1036.	1208.	1381.	2025.
		0.0112	0.0187	0.0274	0.0404	0.0401	0.0382	0.0346	0.0360	0.0385	0.0420	0.0550	0.0793	0.1120	0.1540	0.5000
1.369	0.0063	173.	346.	519.	692.	519.	346.	173.	346.	519.	692.	865.	1038.	1211.	1384.	1930.
		0.0092	0.0137	0.0192	0.0272	0.0266	0.0249	0.0222	0.0235	0.0256	0.0286	0.0374	0.0550	0.0837	0.1275	0.5000
1.369	0.0065	173.	346.	519.	692.	519.	346.	173.	346.	519.	692.	865.	1038.	1211.	1384.	1732.
		0.0114	0.0168	0.0239	0.0355	0.0349	0.0331	0.0289	0.0299	0.0327	0.0368	0.0552	0.0950	0.1520	0.2215	0.5000
1.286	0.0075	174.	348.	521.	695.	521.	348.	174.	348.	521.	695	869.	1043.	1217.	1390.	1942.
		0.0107	0.0158	0.0230	0.0340	0.0332	0.0317	0.0282	0.0292	0.0313	0.0353	0.0492	0.0790	0.1205	0.1690	0.5000
1.412	0.0130	175.	350.	525.	700.	525.	350.	175.	350.	525.	700.	875.	1050.	1225.	1400.	1733.
		0.0162	0.0206	0.0267	0.0366	0.0357	0.0340	0.0302	0.0314	0.0340	0.0376	0.0510	0.0790	0.1260	0.1880	0.5000
1.430	0.0065	176.	352.	527.	703.	527.	352.	176.	352.	527.	703.	879.	1005.	1231.	1406.	1585.
		0.0115	0.0180	0.0269	0.0401	0.0394	0.0369	0.0320	0.0332	0.0369	0.0417	0.0620	0.1055	0.1580	0.2400	0.5000
1.534	0.0063	181.	361.	542.	723.	542.	361.	181.	361.	542.	723.	904.	1084.	1265.	1446.	1702.
		0.0096	0.0147	0.0226	0.0360	0.0351	0.0329	0.0279	0.0297	0.0330	0.0376	0.0567	0.1010	0.1600	0.2350	0.5000
1.639	0.0070	186.	371.	557.	770.	557.	371.	186.	371.	557.	770.	928.	1113.	1299.	1484.	1645.
		0.0124	0.0201	0.0314	0.0547	0.0540	0.0506	0.0449	0.0468	0.0508	0.0572	0.0800	0.1325	0.2050	0.3110	0.5000
1.656	0.0120	186.	373.	559.	745.	559.	373.	186.	373.	559.	745.	932.	1118.	1304.	1490.	1672.
		0.0170	0.0243	0.0342	0.0500	0.0494	0.0465	0.0413	0.0429	0.0470	0.0521	0.0738	0.1240	0.1890	0.3040	0.5000
1.735	0.0148	190.	380.	570.	760.	570.	380.	190.	380.	570.	760.	950.	1140.	1330.	1520.	1872.
		0.0205	0.0274	0.0368	0.0498	0.0491	0.0474	0.0428	0.0439	0.0468	0.0510	0.0688	0.0980	0.1470	0.2140	0.5000
1.778	0.0050	191.	384.	576.	768.	576.	384.	191.	384.	576.	768.	960.	1152.	1344.	1536.	1877.
		0.0091	0.0148	0.0224	0.0336	0.0330	0.0307	0.0261	0.0276	0.0308	0.0350	0.0516	0.0830	0.1030	0.1870	0.5000
1.839	0.0038	195.	390.	584.	779.	584.	390.	195.	390.	584.	779.	974.	1169.	1364.	1558.	2099.
		0.0067	0.0110	0.0177	0.0273	0.0265	0.0247	0.0212	0.0227	0.0250	0.0284	0.0423	0.0700	0.1135	0.1665	0.5000

* Initial slip obtained by extrapolation of curve to zero load

TABLE A1 CONTINUED

Series II, Load parll, perp., parll. to grain of the three members

Grading Modulus ($x10^6$ psi)	Initial Slip* (lb)	Load (lb) and deformation (in.) at each increment														
0.497	0.0070	133. 0.0116	266. 0.0168	399. 0.0238	540. 0.0332	399. 0.0320	266. 0.0303	133. 0.0268	266. 0.0288	399. 0.0306	532. 0.0338	665. 0.0417	798. 0.0572	931. 0.0865	1064. 0.1270	1536. 0.5000
0.671	0.0028	141. 0.0062	282. 0.0113	422. 0.0183	563. 0.0302	422. 0.0299	282. 0.0287	141. 0.0252	282. 0.0263	422. 0.0283	563. 0.0320	704. 0.0490	845. 0.0840	986. 0.1320	1126. 0.1845	1710. 0.5000
0.680	0.0063	141. 0.0107	282. 0.0146	424 0.0201	565. 0.0281	424. 0.0275	282. 0.0260	141. 0.0230	282. 0.0241	424. 0.0260	565. 0.0290	706. 0.0380	847. 0.0574	988. 0.0947	1130. 0.1410	1592. 0.0500
0.697	0.0120	142. 0.0162	284. 0.02 1	426. 0.0278	568. 0.0360	426. 0.0352	284. 0.0335	142. 0.0298	284. 0.0314	426. 0.0338	568. 0.0370	710. 0.0461	852. 0.0655	994. 0.0990	1136. 0.1405	1639. 0.5000
0.785	0.0215	146. 0.0278	292. 0.0343	432. 0.0429	584. 0.0536	432 0.0532	292. 0.0518	146. 0.0478	292. 0.0491	432. 0.0519	584. 0.0550	730. 0.0695	876. 0.1025	1022. 0.1710	1168. 0.2540	1358. 0.5000
0.785	0.0138	146. 0.0187	292. 0.0250	438. 0.0324	584. 0.0418	438. 0.0410	292. 0.0392	146. 0.0353	292. 0.0370	438. 0.0392	584. 0.0430	730. 0.0551	876. 0.0795	1022. 0.1275	1168. 0.1920	1392. 0.5000
0.811	0.0080	147. 0.0131	295. 0.0195	442. 0.0270	589. 0.0374	442. 0.0362	295. 0.0346	147. 0.0310	295. 0.0325	442. 0.0351	589. 0.0388	737. 0.0500	884. 0.0758	1031. 0.1300	1178. 0.2060	1580. 0.500
0.828	0.0045	148. 0.0079	296. 0.0136	444. 0.0208	592. 0.0339	444. 0.0329	296. 0.0313	148. 0.0281	296. 0.0291	444. 0.0313	592. 0.0350	741. 0.0540	889. 0.0910	1037. 0.1495	1185. 0.2210	1515. 0.5000
0.846	0.0090	149. 0.0120	298. 0.0160	447. 0.0232	596. 0.0335	447. 0.0327	298. 0.0308	149. 0.0263	298. 0.0279	447. 0.0308	596. 0.0348	745. 0.0507	893. 0.0900	1042. 0.1680	1191. 0.2580	1367. 0.5000
0.872	0.0046	150. 0.0088	300. 0.0139	450. 0.0205	600. 0.0305	450. 0.0297	300. 0.0278	150. 0.0239	300. 0.0252	450. 0.0279	600. 0.0317	750. 0.0456	901. 0.0765	1051. 0.1500	1201. 0.2480	1415. 0.5000
0.872	0.0053	150 0.0092	300. 0.0144	450. 0.0220	600. 0.0337	450. 0.0328	300. 0.0310	150. 0.0269	300. 0.0280	450. 0.0309	600. 0.0352	750. 0.0532	901. 0.0915	1051. 0.1440	1201. 0.2100	1478. 0.5000
0.872	0.0076	150. 0.0115	300. 0.0158	450. 0.0228	600. 0.0330	450. 0.0327	300. 0.0318	150. 0.0282	300. 0.0290	450. 0.0309	600. 0.0339	750. 0.0481	901 0.0680	1051. 0.1075	1201. 0.1680	1524. 0.5000
0.881	0.0135	151. 0.0153	301. 0.0199	452. 0.0249	602. 0.0311	542. 0.0307	301. 0.0297	151. 0.0270	301. 0.0279	452. 0.0293	602. 0.0319	753. 0.0384	903. 0.0510	1054. 0.0725	1204. 0.1020	1840. 0.5000
0.881	0.0050	151. 0.0108	301. 0.0188	452. 0.0289	602. 0.0440	452. 0.0437	01. 0.0422	151. 0.0379	301. 0.0399	452. 0.0418	602. 0.0459	753. 0.0690	903. 0.1330	1054. 0.2080	1204. 0.3030	1380. 0.5000
0.881	0.0067	151. 0.0100	301. 0.0142	452. 0.0202	602. 0.0312	542. 0.0305	301. 0.0287	151. 0.0249	301. 0.0267	452. 0.0289	602. 0.0326	735. 0.0450	903. 0.0742	1054. 0.1295	1204. 0.1965	1541. 0.5000
0.915	0.0024	152. 0.0082	304. 0.0167	456. 0.0277	608. 0.0452	456. 0.0444	304. 0.0419	152. 0.0322	304. 0.0367	456. 0.0417	608. 0.0479	761. 0.0850	913. 0.1970	1065. 0.2770	1217. 0.4280	1248. 0.5000
0.915	0.0013	152. 0.0082	304. 0.0082	456. 0.0139	608. 0.0229	456. 0.0220	304. 0.0202	152. 0.0265	304. 0.0178	456. 0.0203	608. 0.0240	761. 0.0344	913. 0.0539	1065. 0.0847	1217. 0.1320	1678. 0.5000
0.942	0.0071	153. 0.0095	307. 0.0150	460. 0.0212	613. 0.0317	460. 0.0302	307. 0.0274	153. 0.0238	307. 0.0250	460. 0.0279	613. 0.0314	767. 0.0440	920. 0.0700	1073. 0.1165	1226. 0.1895	1508. 0.5000
0.942	0.0088	153. 0.0128	307. 0.0189	460. 0.0272	613. 0.0405	460. 0.0393	307. 0.0370	153. 0.0326	307. 0.0341	460. 0.0373	613. 0.0421	767. 0.0660	920. 0.1230	1073. 0.2090	1226. 0.2970	1422. 0.5000
0.976	0.0096	155. 0.0148	310. 0.0218	465. 0.0318	620. 0.0474	465. 0.0461	310. 0.0436	155. 0.0384	310. 0.0402	465. 0.0440	620. 0.0490	775. 0.0740	929. 0.1200	1084. 0.1905	1239. 0.2840	1374. 0.5000
1.003	0.0144	156. 0.0183	312. 0.0241	468. 0.0314	624. 0.0422	468. 0.0414	312. 0.0398	156. 0.0358	312. 0.0376	468. 0.0398	624. 0.0432	781. 0.0563	937. 0.0855	1093. 0.1400	1249. 0.2105	1635. 0.5000
1.037	0.0096	158. 0.0132	315. 0.0182	473. 0.0251	631. 0.0338	473. 0.0329	315. 0.0311	158. 0.0273	315. 0.0288	473. 0.0311	631. 0.0341	789. 0.0457	946. 0.0658	1104. 0.1060	1262. 0.1650	1644. 0.5000
1.037	0.0	158. 0.0061	315. 0.0135	473. 0.0232	631. 0.0340	473. 0.0328	315. 0.0309	158. 0.0270	315. 0.0289	473. 0.0314	631. 0.0353	789. 0.0434	946. 0.0572	1104. 0.0783	1262. 0.1145	1916. 0.5000

TABLE A1 CONTINUED

Series II, Load parll, perp., parll. to grain of the three members

Grading Modulus ($x10^6$ psi)	Initial Slip* (lb)	Load (lb) and deformation (in.) at each increment														
1.081	0.0070	160.	319.	479.	639.	479.	319.	160.	319.	479.	639.	799.	958.	1118.	1278.	1395.
		0.0129	0.0216	0.0339	0.0535	0.0529	0.0506	0.0444	0.0466	0.0506	0.0566	0.0923	0.1568	0.2278	0.3298	0.05000
1.081	0.0043	160.	319.	479.	639.	479.	319.	160.	319.	479.	639.	799.	958.	1118.	1278.	1610.
		0.0080	0.0120	0.0176	0.0262	0.0254	0.0233	0.0205	0.0220	0.0245	0.0277	0.0417	0.0697	0.1180	0.1755	0.0500
1.081	0.0045	160.	319.	479.	639.	479.	319.	160.	319.	479.	639.	799.	958.	1118.	1278.	1458.
		0.0095	0.0161	0.0273	0.0477	0.0466	0.0435	0.0375	0.0399	0.0445	0.0525	0.0905	0.1595	0.2275	0.3455	0.5000
1.186	0.0015	165.	329.	494.	658.	494.	329.	165.	329.	494.	658.	823.	988.	1152.	1317.	1600
		0.0058	0.0110	0.0202	0.0360	0.0348	0.0329	0.0284	0.0300	0.0329	0.0381	0.0650	0.1140	0.1720	0.2350	0.5000
1.203	0.0115	165.	331.	496.	662.	496.	331.	165.	331.	496.	662.	827.	992	1158	1323.	1925.
		0.0152	0.0197	0.0263	0.0357	0.0350	0.0328	0.0293	0.0308	0.0335	0.0373	0.0519	0.0802	0.1270	0.1785	0.5000
1.264	0.0065	168.	336.	505.	673.	505.	336.	168.	336.	505.	673.	841.	1009.	1177.	1346.	1370.
		0.0111	0.0206	0.0372	0.0777	0.0767	0.0724	0.0643	0.0679	0.0742	0.0833	0.1405	0.2125	0.3095	0.4655	0.5000
1.290	0.0075	169.	339.	508.	678.	508	339.	169.	339.	508.	678.	847.	1016.	1186.	1355.	1760.
		0.0116	0.0168	0.0244	0.0362	0.0350	0.0326	0.0280	0.0302	0.0334	0.0382	0.0560	0.0915	0.1458	0.2120	0.5000
1.299	0.0068	170.	340.	509.	679.	509.	340.	170.	340.	509.	679.	849.	1019.	1189.	1358.	1890.
		0.0102	0.0152	0.0222	0.0352	0.0348	0.0325	0.0275	0.0292	0.0323	0.0368	0.0555	0.0984	0.1490	0.2050	0.5000
1.316	0.0035	171.	341.	512.	682.	512.	341.	171.	341.	512.	682.	853.	1024.	1194.	1365.	1665.
		0.0079	0.0129	0.0206	0.0317	0.0311	0.0289	0.0232	0.0252	0.0288	0.0331	0.0485	0.0816	0.1445	0.2250	0.5000
1.325	0.0043	171.	342.	513.	684.	513.	342.	171.	342.	513.	684.	855.	1026.	1197.	1368.	1830.
		0.0076	0.0119	0.0195	0.0327	0.0320	0.0301	0.0257	0.0269	0.0301	0.0348	0.0570	0.1060	0.1585	0.2080	0.5000
1.360	0.0112	173.	345.	518.	690.	518.	345.	173.	345.	518.	690.	863.	1036.	1208.	1381.	1705.
		0.0164	0.0222	0.0310	0.0438	0.0431	0.0412	0.0370	0.0380	0.0403	0.0445	0.0614	0.1030	0.1630	0.2300	0.5000
1.369	0.0075	174.	346.	519.	692.	519.	346.	173.	346.	519.	692.	865.	1038.	1211.	1384.	1886.
		0.0118	0.0172	0.0252	0.0371	0.0360	0.0340	0.0299	0.0320	0.0346	0.0389	0.0606	0.1000	0.1510	0.1990	0.5000
1.369	0.0100	173.	346.	519.	692.	519.	346.	173.	346.	519.	692.	865.	1038.	1211.	1384.	1560.
		0.0135	0.0196	0.0297	0.0503	0.0499	0.0477	0.0426	0.0442	0.0476	0.0542	0.0915	0.1520	0.2240	0.3140	0.5000
1.386	0.0090	174.	348.	521.	695.	521.	348.	174.	348.	521.	695.	869.	1043.	1217.	1390.	1775.
		0.0126	0.0179	0.0272	0.0421	0.0412	0.0392	0.0341	0.0353	0.0389	0.0443	0.0715	0.1240	0,1850	0.2560	0.5000
1.412	0.0035	175.	350.	525.	700.	525.	350.	175.	350.	525.	700.	875.	1050.	1225.	1400.	1730.
		0.0058	0.0108	0.0189	0.0330	0.0320	0.0293	0.0240	0.0264	0.0301	0.0354	0.0585	0.1058	0.1650	0.2390	0.5000
1.430	0.0050	176.	352.	527.	703.	527.	352.	176.	352.	527.	703.	879.	1055.	1231.	1406.	1615
		0.0103	0.0181	0.0288	0.0467	0.0457	0.0428	0.0363	0.0391	0.0432	0.0492	0.0800	0.1350	0.2040	0.2850	0.5000
1.534	0.0070	181.	361.	542.	723.	542.	361.	181.	361.	542.	723.	904.	1084.	1265.	1446.	1685.
		0.0117	0.0185	0.0285	0.0467	0.0460	0.0432	0.0373	0.0393	0.0440	0.0500	0.0800	0.1315	0.1940	0.2630	0.5000
1.639	0.0064	186.	371.	557.	742.	557.	371.	186.	371.	557.	742.	928.	1113.	1299.	1484.	1570.
		0.0110	0.0178	0.0287	0.0532	0.0528	0.0502	0.0449	0.0460	0.0499	0.0563	0.0920	0.1500	0.2190	0.3410	0.5000
1.656	0.0040	186.	373.	559.	745.	559.	373.	186.	373.	559.	745.	932.	1118.	1304.	1409.	1615.
		0.0079	0.0140	0.0228	0.0382	0.0376	0.0351	0.0295	0.0310	0.0352	0.0409	0.0685	0.1190	0.1900	0.3010	0.5000
1.735	0.0046	190.	380.	570.	787.	570.	380.	190.	380.	570.	787.	950.	1140.	1330.	1520.	1687.
		0.0089	0.0149	0.0249	0.0470	0.0462	0.0441	0.0384	0.0402	0.0434	0.0508	0.0837	0.1405	0.2185	0.3010	0.5000
1.778	0.0025	192.	384.	576.	768.	576.	384.	192.	384.	576.	768.	960.	1152.	1344.	1536.	1834.
		0.0073	0.0133	0.0222	0.0372	0.0363	0.0338	0.0284	0.0299	0.0342	0.0405	0.0676	0.1125	0.1740	0.2550	0.5000
1.839	0.0045	195.	390.	584.	779.	584.	390.	195.	390.	584.	779.	974.	1169.	1364.	1558.	2102.
		0.0078	0.0123	0.0185	0.0272	0.0265	0.0248	0.0220	0.0231	0.0253	0.0283	0.0397	0.0615	0.0965	0.1440	0.5000

TABLE A2 PROTOTYPE NAIL-GLUED JOINT DATA

LOAD ACTING PERP., PARLL., PERP. TO GRAIN OF THE THREE MEMBERS

Label of Prototype torsion element	Average grading modulus	Joint No.	Load at failure	Average glueline stress at failure	Layer where failure occurred 1st/2nd layers	2nd/3rd layers	Moisture content
	x10^{6}psi		lb	psi	btm	top	%
T4	1.128	1	5100	239.9		•	11.5
		2	850	36.4	•		10.6
		3	1570	68.5	•		11.4
		4	1035	43.8		•	11.1
		5	865	37.0	•		12.5
		6	2035	87.6	•		12.3
		7	3355	153.1		•	10.9
		8	2760	118.4		•	12.7
		9	3895	167.2		•	12.7
		10	2940	126.4		•	12.0
		11	3240	138.2	•		13.0
		12	1460	62.0	•		13.0
T8	0.914	1	3390	191.2	•		10.9
		2	795	33.4	•		11.4
		3	2085	89.9	•		12.0
		4	3610	154.7		•	11.6
		5	1980	84.3		•	12.0
		6	775	33.5	•		11.9
		7	4805	212.5		•	10.7
		8	1150	46.4	•		12.0
		9	2045	85.9	•		12.7
		10	2955	124.9	•		11.9
		11	2420	105.2		•	11.7
		12	2405	103.0	•		11.7
T12	0.759	1	4115	194.7		•	10.8
		2	1555	66.0	•		12.3
		3	1320	56.0	•		11.9
		4	2760	117.8		•	12.0
		5	3415	144.3	•		11.5
		6	2335	99.7	•		12.1
		7	6800	327.4	•		10.5
		8	1580	67.4	•		12.3
		9	2400	101.8	•		12.0
		10	2370	101.6		•	11.8
		11	4820	203.6	•		11.8
		12	3690	156.8	•		12.0
T16	0.585	1	4160	195.7		•	10.7
		2	960	41.1		•	10.7
		3	3370	147.1		•	10.5
		4	1270	53.8		•	9.9
		5	2330	99.7		•	10.5
		6	1660	71.5	•		10.5
		7	6090	281.2		•	11.0
		8	1565	67.1	•		11.1
		9	2455	105.4		•	10.7
		10	2760	118.7		•	10.6
		11	2800	122.2		•	10.6
		12	1210	51.4		•	
Average	0.8465			93.47 (Excluding Nos 1 & 7) 224.46 (for Nos 1 & 7 only)			11.3

TABLE A2 CONTINUED - LOAD-DEFORMATION DATA OF PROTOTYPE NAIL-GLUED JOINTS

Label of prototype torsion element	Joint No.	Joint deformation (in.) as observed between testing machine platens at a load (lb) of:																Maximum load
		200	400	600	800	600	400	200	400	600	800	1000	1200	1400	1600	1800	2000	lb
T4	2	.0132	.0193	.0236	.0270	.0257	.0230	.0182	.0219	.0253	.0277							850
	3	.0115	.0173	.0209	.0252	.0248	.0215	.0175	.0201	.0228	.0248	.0278	.0314	.0355				1570
	4	.0085	.0130	.0166	.0196	.0182	.0162	.0131	.0153	.0176	.0200	.0249						1035
	8	.0095	.0126	.0150	.0171	.0164	.0150	.0127	.0143	.0159	.0173	.0189	.0207	.0224	.0244	.0263	.0284	2760
	10	.0066	.0096	.0119	.0136	.0129	.0114	.0086	.0103	.0123	.0138	.0154	.0172	.0187	.0203	.0218	.0237	2940
T8	3	.0124	.0159	.0182	.0203	.0195	.0181	.0158	.0172	.0190	.0203	.0220	.0238	.0255	.0275	.0302	.0335	2085
	5	.0113	.0153	.0180	.0202	.0193	.0175	.0145	.0169	.0187	.0203	.0221	.0242	.0261	.0284	.0319		1980
	9	.0077	.0166	.0148	.0175	.0161	.0148	.0120	.0138	.0157	.0176	.0198	.0220	.0242	.0264	.0291	.0324	2045
	11	.0102	.0140	.0168	.0191	.0177	.0163	.0130	.0154	.0175	.0193	.0213	.0231	.0247	.0267	.0288	.0315	2420
T12	3	.0075	.0115	.0150	.0183	.0173	.0151	.0109	.0137	.0164	.0189	.0230	.0266					1320
	5	.0055	.0089	.0116	.0138	.0130	.0111	.0086	.0104	.0123	.0140	.0157	.0173	.0188	.0202	.0216	.0229	3415
	9	.0078	.0118	.0151	.0177	.0175	.0160	.0127	.0144	.0164	.0180	.0200	.0219	.0237	.0256	.0278	.0314	2400
	11	.0089	.0129	.0160	.0181	.0171	.0153	.0125	.0147	.0167	.0182	.0199	.0217	.0235	.0250	.0266	.0280	4820
T16	3	.0147	.0204	.0240	.0267	.0258	.0239	.0202	.0230	.0251	.0270	.0282	.0303	.0327	.0345	.0362	.0379	3370
	5	.0138	.0176	.0204	.0228	.0221	.0203	.0173	.0194	.0213	.0230	.0249	.0268	.0288	.0310	.0342	.0368	2330
	9	.0089	.0131	.0160	.0184	.0174	.0158	.0131	.0149	.0168	.0185	.0203	.0225	.0245	.0267	.0291	.0314	2455
	11	.0111	.0158	.0189	.0214	.0205	.0186	.0152	.0177	.0198	.0215	.0233	.0250	.0266	.0280	.0296	.0311	2800

TABLE A3 LOAD-DEFORMATION DATA FROM MODEL NAILED JOINTS

SERIES 1 LOAD PERP.,PARLL.,PERP.TO GRAIN OF THE THREE MEMBERS

SLIP(.0001) AT 6.5LB INTERVALS, P EQUALS 65LBS

GRADING MODULUS	INITIAL SLIP	0.1P	0.2P	0.3P	0.4P	0.3P	0.2P	0.1P	0.2P	0.3P	0.4P	0.5P	0.6P	0.7P	0.8P	0.9P	1.0P	1.1P	1.2P	1.3P	1.4P	1.5P
0.0P																						
0.3750	-9	0	15	31	49	45	38	27	32	41	50	68	96	139	210	322	487	779				
0.4350	-4	0	6	13	21	20	17	11	13	17	22	33	52	98	192	360	615	1015				
0.5250	-7	0	4	13	26	23	16	11	12	18	27	47	82	170	347	659						
0.5550	-6	0	7	18	28	26	22	14	17	23	28	41	55	73	98	132	175	225	284	379	571	995
0.5650	-4	0	8	18	31	30	14	11	22	23	32	45	65	95	171	296	501					
0.6250	-7	0	8	17	27	24	19	13	16	23	26	39	57	96	184	301	460	1114				
0.6300	-4	0	6	15	28	27	26	25	25	26	29	53	106	206	320	477	717	1207				
0.6800	-2	0	7	19	47	44	37	28	32	40	51	133	302	480	744							
0.6900	-7	0	11	26	44	42	34	24	28	36	44	63	93	137	214	306	422	584	870			
0.7150	-4	0	6	17	30	28	21	11	15	23	31	60	150	720								
0.7500	-7	0	9	23	37	35	29	21	24	31	39	54	80	140	262	470	1260					
0.7800	-20	0	25	51	92	88	74	54	59	76	96	256	533	856	1393							
0.7850	-11	0	17	35	55	45	34	18	28	41	55	80	104	139	189	289	459	754				
0.8350	-5	0	6	17	29	26	16	6	14	22	30	51	84	157	277	409	539	813				
0.8350	-7	0	9	22	39	39	38	35	34	35	42	79	195	492	933							
0.8800	-5	0	7	16	27	26	23	17	18	21	28	48	82	139	270	427	596	837				
0.9250	-6	0	7	18	33	28	19	5	13	23	31	47	74	134	313	875						
0.9350	-4	0	6	14	21	20	15	9	11	16	23	36	51	80	130	228	413	837				
0.9650	-4	0	6	13	25	25	21	13	15	19	24	41	66	104	170	259	394	688				
0.9850	-11	0	13	27	44	44	43	39	38	43	51	74	164	392	934							
0.9950	-2	0	5	17	46	42	37	30	30	37	48	105	239	413	686	923	1218					
1.0400	-6	0	7	15	28	26	18	8	13	19	28	48	98	197	304	407	569	856				
1.0450	-3	0	4	11	20	21	20	16	16	18	25	38	67	140	260	426	634	979				
1.1150	-5	0	6	17	29	27	17	5	8	17	27	43	68	126	268	517	987					
1.1500	-2	0	3	10	15	13	10	3	9	11	14	24	46	108	210	470						
1.1950	-9	0	13	30	48	40	30	16	28	38	50	76	124	212	327	452	629	897				
1.2450	-8	0	14	27	44	39	31	20	27	35	45	58	89	155	275	487	855					
1.2650	-7	0	8	17	31	30	24	15	17	24	31	45	67	115	220	374	544	802				
1.3350	-17	0	22	46	74	72	65	48	49	58	73	100	139	219	363	525	684	926				
1.3800	-6	0	8	18	32	27	18	8	15	21	28	47	66	94	139	207	314	457	702	920		
1.4400	-9	0	7	14	25	21	12	2	8	16	26	38	50	69	90	128	188	286	425	660		
1.4950	-2	0	2	6	15	14	12	8	9	13	16	29	56	104	176	275	384	544	754	1059		
1.5450	-3	0	6	16	27	27	23	11	14	20	28	45	74	117	187	268	443	733	971	1285		
1.6000	-5	0	7	14	23	21	18	13	15	18	26	35	56	97	167	256	406	627	887			
1.6400	-4	0	8	16	25	25	19	12	16	19	27	39	59	84	169	294	458	768	1135			
1.6850	-11	0	13	28	45	44	41	33	36	42	48	64	103	271	425	623						
1.7350	-2	0	6	16	35	34	28	23	23	29	36	69	154	296	425	588	761	1046				
1.7650	-12	0	13	29	47	44	36	24	30	39	50	66	96	155	246	412	697	1243				
1.8100	-3	0	5	12	17	16	13	8	12	14	17	27	39	60	101	176	266	389	580	1096		
1.9450	-7	0	10	22	37	34	27	18	23	31	39	53	72	99	137	199	280	373	537	963		

AVERAGE MODULUS AND SLIP VALUES

1.0724	-6	0	8	20	34	32	26	17	21	27	36	59	106	199

TABLE A3 CONTINUED

SERIES 2 LOAD PARLL.,PERP.,PARLL.TO GRAIN OF THE THREE MEMBERS

SLIP(.0001) AT 6.5LB INTERVALS, P EQUALS 65LBS

GRADING MODULUS	INITIAL SLIP	0.1P	0.2P	0.3P	0.4P	0.3P	0.2P	0.1P	0.2P	0.3P	0.4P	0.5P	0.6P	0.7P	0.8P	0.9P	1.0P	1.1P	1.2P	1.3P	1.4P	1.5P
0.0P																						
0.3770	-1	0	2	7	18	16	11	4	7	11	18	43	129	399	686	1044						
0.4270	-8	0	11	27	46	40	30	18	23	33	48	71	116	189	336	560	866					
0.4530	-7	0	8	18	29	25	19	8	12	20	30	48	78	141	288	512	848					
0.5170	-2	0	4	11	23	20	11	3	9	16	24	58	159	358	676	973						
0.5670	-1	0	4	12	34	33	27	22	23	28	38	81	175	349	566	896						
0.5770	-7	0	12	29	51	50	44	36	40	45	53	100	285	675	1027							
0.6200	-7	0	9	25	45	40	31	17	22	34	46	70	115	236	480	718	961	1209				
0.6330	-3	0	5	19	32	31	23	15	18	24	33	53	101	175	276	393	507	642	807	988		
0.6730	-9	0	13	34	77	75	67	59	62	70	87	247	548	808	1185							
0.6730	-7	0	8	17	32	28	20	9	13	22	33	63	163	412	713	1149						
0.7130	-5	0	8	20	43	41	36	22	27	34	46	81	180	445	870							
0.7270	-2	0	4	14	29	28	21	12	17	21	29	45	81	155	355	747						
0.7570	-9	0	15	36	65	61	47	32	41	54	70	105	174	315	527	778	1076					
0.7930	-3	0	4	22	60	52	35	21	31	47	68	174	442	904								
0.8000	-5	0	12	30	68	61	41	18	31	53	77	149	313	574	879	1129						
0.8300	-6	0	8	20	40	40	36	30	28	33	41	82	175	358	593	1190						
0.8400	-4	0	7	19	34	33	30	22	24	29	34	65	175	476	593							
0.8770	-6	0	9	20	37	37	32	26	30	32	39	68	150	330	610	907						
0.8870	-6	0	10	25	46	41	37	26	31	39	48	82	200	511	799	1135						
0.9170	-4	0	6	13	22	20	13	1	7	16	28	49	91	189	367	584						
0.9230	-3	0	5	12	28	33	27	21	25	32	40	78	203	512	592							
0.9530	-3	0	5	12	25	23	18	11	15	19	26	48	96	194	384	642						
0.9930	-7	0	13	30	53	44	33	14	23	36	55	99	199	336	497	716	1146					
1.0030	-2	0	6	18	34	31	29	24	25	29	34	73	151	330	536	808	1110					
1.0330	-5	0	9	24	45	44	38	28	32	38	48	79	139	260	618							
1.0330	-6	0	10	27	53	50	40	21	27	40	59	122	321	907								
1.1070	-13	0	17	36	60	54	44	26	32	45	64	85	117	169	242	390	596	945				
1.1830	-10	0	14	33	55	53	46	38	42	51	60	91	143	235	377	612						
1.2300	-13	0	17	37	64	56	43	26	38	52	70	119	285	527	799	976	1197					
1.2770	-6	0	9	26	48	46	39	26	30	39	52	96	240	518	1077							
1.3330	-4	0	6	18	36	35	30	22	26	32	39	71	137	351	786							
1.4430	-1	0	2	9	20	19	17	11	13	17	24	40	85	199	428	868						
1.4870	-9	0	12	35	68	66	56	37	45	58	71	113	189	377	711							
1.5230	-5	0	5	11	22	20	16	9	10	13	24	34	60	106	186	294	428	623	928			
1.5700	-1	0	2	9	20	20	19	13	12	16	21	41	82	159	338	730	1200					
1.6330	-4	0	5	14	25	23	18	14	16	22	27	42	59	91	151	248	438	801				
1.6700	-9	0	10	23	37	37	34	22	25	32	40	63	113	220	494	1134						
1.7230	-6	0	8	18	31	28	21	10	14	22	33	50	75	108	155	236	350	530	748			
1.7630	-4	0	7	16	29	25	20	12	14	22	30	49	83	140	272	488	850					
1.8200	-4	0	6	14	30	28	23	15	19	24	31	55	104	199	361	649						
AVERAGE MODULUS AND SLIP VALUES																						
1.0089	-5	0	8	20	40	37	30	20	24	32	43	79	168	348								
AVERAGE FOR BOTH SERIES																						
1.0407	-5	0	8	20	37	35	28	18	23	30	39	69	137	273								

TABLE A4. COEFFICIENTS DETERMINED FROM PROTOTYPE AND MODEL JOINT DATA

SERIES 1

PROTOTYPE JOINTS

GRADING MODULUS E LB/SQIN	"ELASTIC STIFFNESS" e LB/IN	FITTED COEFFICIENTS A LB/IN	B LB	C IN^{-1}	D
0.4969	63333.	1996.6	953.9	-23.25	0.7696
0.6713	89787.	1671.6	768.9	-39.67	0.7236
0.6800	81538.	2055.1	741.7	-36.95	0.9223
0.6974	78165.	1542.0	800.0	-32.70	0.9345
0.7846	55443.	1511.0	734.4	-40.05	0.8190
0.7846	58013.	632.1	1063.5	-15.75	0.6939
0.8108	51395.	1376.1	985.0	-22.36	0.8275
0.8282	45538.	1610.8	591.0	-53.61	0.7884
0.9456	64316.	1377.8	838.7	-27.96	0.6996
0.8718	43478.	1727.8	769.9	-37.39	0.9126
0.8718	112500.	1810.6	910.9	-54.67	0.8079
0.9718	50000.	1323.0	732.8	-35.94	0.7121
0.8805	71024.	1762.3	997.1	-27.50	0.6030
0.8805	46256.	1401.8	693.5	-27.94	0.5145
0.8805	53059.	1537.5	762.2	-37.58	0.7543
0.9154	60800.	1591.5	742.3	-37.90	0.6291
0.9154	69618.	1764.6	896.7	-38.56	1.1793
0.9415	73016.	1350.7	939.9	-27.61	0.7176
0.9415	38016.	1358.3	691.8	-25.85	0.7641
0.9764	53143.	1466.7	919.9	-26.28	0.7418
1.0026	36000.	1375.6	766.5	-19.14	0.7867
1.0374	51135.	1621.8	720.2	-37.67	0.8645
1.0374	67092.	1725.7	885.4	-56.06	1.0276
1.0462	63624.	1813.0	898.7	-40.90	1.2096
1.0636	73953.	1793.9	997.3	-40.53	1.0098
1.0723	70294.	2360.6	681.9	-80.09	1.1954
1.0810	44976.	1584.7	725.4	-37.63	1.0710
1.0810	74264.	1358.7	1006.1	-35.94	0.8580
1.0810	38016.	1565.7	720.1	-33.85	0.7683
1.1856	56994.	1723.9	867.9	-19.39	0.5478
1.2031	69028.	2236.3	916.7	-48.05	1.0107
1.2641	31173.	1575.9	661.6	-30.26	0.7018
1.2903	55326.	1877.3	932.8	-38.45	0.8635
1.2990	59882.	2209.4	875.3	-42.14	0.8145
1.3164	55543.	1514.6	989.3	-36.24	0.8647
1.3251	63727.	2268.2	857.2	-36.35	0.6495
1.3600	72308.	1590.8	1013.1	-26.13	0.7355
1.3687	64074.	2064.4	979.4	-26.15	0.7460
1.3687	53782.	1774.1	787.8	-37.30	0.7440
1.3862	57253.	2060.9	832.9	-38.68	0.8093
1.4123	51471.	1835.3	911.4	-36.69	0.7617
1.4298	45236.	1877.5	817.9	-41.34	1.0873
1.5344	49050.	1826.9	911.2	-28.39	0.7789
1.6390	56447.	2153.1	808.5	-34.02	0.7645
1.6564	55622.	1365.7	1031.8	-27.19	0.7596
1.7349	56857.	1695.4	950.3	-27.39	0.6942
1.7785	55120.	1968.1	982.7	-32.82	0.7627
1.8395	101565.	1858.9	1329.5	-29.05	0.8197

MODEL JOINTS

GRADING MODULUS E LB/SQIN	"ELASTIC STIFFNESS" e LB/IN	FITTED COEFFICIENTS A LB/IN	B LB	C IN^{-1}	D
0.3750	8666.7	206.7	55.19	-87.7	0.8650
0.4350	18571.4	236.4	49.16	-200.1	0.7187
0.5250	12580.6	256.9	41.67	-183.0	0.5388
0.5550	13928.6	206.5	78.50	-81.1	0.7866
0.5650	9512.2	193.2	53.98	-133.2	0.7355
0.6250	14444.4	225.6	52.53	-178.9	0.9587
0.6300	55714.2	313.2	41.35	-156.9	0.5660
0.6800	9285.7	255.2	32.34	-142.6	0.3651
0.6900	9750.0	316.0	51.32	-99.8	0.7637
0.7150	10000.0	60.6	40.95	-169.8	0.6011
0.7500	11470.6	149.3	50.30	-135.3	0.8493
0.7800	4875.0	205.4	28.20	-167.7	1.1770
0.7850	5270.3	269.9	51.39	-106.9	0.9967
0.8350	8297.9	343.7	43.19	-174.7	0.6880
0.8350	35454.4	170.8	29.84	-188.0	0.6424
0.8800	18571.4	331.6	43.55	-189.0	0.7165
0.9250	7222.2	94.8	49.87	-145.0	0.7676
0.9350	15000.0	182.5	56.25	-159.4	0.7412
0.9650	16956.5	246.3	53.55	-132.2	0.6711
0.9850	22941.2	147.5	39.14	-186.6	1.0648
0.9950	11470.6	269.6	32.31	-172.6	0.3685
1.0400	9750.0	379.9	40.17	-198.4	0.7399
1.0450	30000.0	292.2	44.85	-182.6	0.5729
1.1150	8478.3	195.0	54.10	-145.2	0.7519
1.1500	16956.5	118.5	52.55	-119.0	0.4367
1.1950	5909.1	339.4	41.97	-118.6	0.7930
1.2450	7959.2	209.4	47.43	-144.0	0.9425
1.2650	12187.5	278.6	48.24	-173.7	0.8870
1.3350	7647.1	406.3	36.00	-148.2	1.2804
1.3800	8863.6	311.5	56.01	-122.8	0.7874
1.4400	8297.9	303.3	62.94	-159.9	1.0309
1.4950	26000.0	453.6	43.91	-310.2	0.6017
1.5450	11818.2	288.2	51.04	-118.4	0.5858
1.6000	16956.5	267.5	53.82	-140.4	0.7327
1.6400	13928.5	258.3	51.49	-172.0	0.7855
1.6850	14444.5	213.9	43.55	-141.2	0.9446
1.7350	15600.0	406.9	33.42	-275.1	0.6095
1.7650	7959.2	208.8	49.29	-119.1	0.9714
1.8100	21666.7	314.4	56.79	-194.8	0.7408
1.9450	9750.0	225.3	65.07	-85.1	0.8002

A4 CONTINUED

SERIES 2

PROTOTYPE JOINTS

GRADING MODULUS E LB/SQIN $\times 10^6$	"ELASTIC STIFFNESS" e LB/IN	FITTED COEFFICIENTS A LB/IN	B LB	C IN^{-1}	D
0.4969	60149.	1368.3	923.1	-33.38	1.0490
0.6713	71525.	2031.1	745.2	-34.61	0.7540
0.6800	76396.	1410.7	937.6	-34.17	0.8239
0.6974	63582.	1559.6	909.9	-39.10	1.0345
0.7846	67385.	1181.0	852.7	-34.54	1.0016
0.7846	61690.	1072.5	944.5	-32.08	0.9898
0.8108	62253.	1321.3	913.4	-34.61	1.0642
0.8282	69921.	1540.2	821.2	-33.28	0.8102
0.8456	56943.	1104.2	877.3	-33.56	0.6702
0.8718	62500.	1160.6	889.4	-36.77	0.8220
0.8718	59603.	1224.0	923.0	-27.63	0.7165
0.8718	85714.	1019.9	1076.3	-19.65	0.6100
0.8805	100222.	1495.8	1179.4	-30.80	0.8016
0.8805	63972.	1409.3	744.1	-37.66	0.9653
0.8805	64429.	1452.5	902.5	-36.78	0.7483
0.9154	31777.	1035.8	760.4	-27.16	0.7800
0.9154	65611.	1443.5	1041.9	-32.03	0.7912
0.9415	59355.	1145.7	1001.0	-29.38	0.7787
0.9415	52874.	1454.2	766.0	-40.28	0.8114
0.9764	47449.	1050.3	916.5	-19.35	0.6685
1.0026	67826.	1597.6	912.5	-37.01	0.8654
1.0374	71128.	1144.8	1110.5	-30.40	0.9387
1.0374	61830.	1116.7	1194.0	-24.69	1.0870
1.0462	75238.	1939.2	1020.8	-40.61	0.9681
1.0636	80847.	1168.6	1150.7	-30.18	0.8487
1.0723	53708.	1697.1	958.2	-27.98	1.1952
1.0810	55057.	1450.9	836.6	-30.45	0.9452
1.0810	72030.	1372.8	1034.1	-29.18	0.7994
1.1856	62614.	1322.0	1024.0	-32.71	0.8612
1.0810	59136.	1331.1	972.2	-22.78	1.1101
1.2031	82833.	1871.9	1086.8	-36.29	0.9287
1.2641	63924.	1360.9	941.2	-28.92	1.1767
1.2903	121190.	1282.3	1381.9	-25.88	0.9088
1.2990	71189.	1525.7	1143.3	-30.49	1.1086
1.3164	66797.	1760.9	1058.7	-36.57	1.0558
1.3251	67500.	1664.9	1074.6	-31.60	1.0814
1.3600	78333.	1899.6	1146.0	-25.60	1.0831
1.3687	91053.	1546.6	1234.9	-27.45	0.6849
1.3687	71586.	1684.1	973.7	-32.71	0.7690
1.3862	80775.	2005.3	1031.6	-31.59	0.7547
1.4123	76087.	1416.2	1122.9	-29.70	0.7049
1.4298	59213.	1085.2	1106.1	-21.63	0.7640
1.5344	60899.	1555.3	1014.3	-34.19	0.8095
1.6390	52851.	1351.9	1030.7	-21.09	0.7528
1.6564	57333.	1462.3	1022.0	-28.99	0.8918
1.7349	75000.	1672.2	1156.2	-25.88	0.8574
1.7785	70366.	1590.3	1200.7	-29.13	0.8245
1.8395	87819.	1858.5	1243.8	-27.25	0.7028

MODEL JOINTS

GRADING MODULUS E LB/SQIN $\times 10^6$	"ELASTIC STIFFNESS" e LB/IN	FITTED COEFFICIENTS A LB/IN	B LB	C IN^{-1}	D
0.3770	13928.6	226.5	36.74	-550.6	0.5262
0.4270	6724.1	252.3	43.74	-125.5	0.7776
0.4530	9069.8	227.4	45.79	-166.5	0.8255
0.5170	9512.2	248.8	35.18	-319.9	0.5569
0.5670	13928.6	368.0	30.20	-394.4	0.4291
0.5770	12187.5	149.7	34.99	-180.7	0.7812
0.6200	6842.1	262.0	39.31	-178.7	0.8370
0.6330	11142.9	499.5	38.15	-154.7	0.4756
0.6730	8478.3	220.8	26.72	-249.9	0.8408
0.6730	8297.9	193.8	36.99	-274.7	0.9842
0.7130	8666.7	165.4	37.62	-181.8	0.7055
0.7270	11470.6	131.6	47.29	-129.5	0.5128
0.7570	5492.9	248.0	38.62	-107.4	0.7301
0.7930	4534.9	187.7	29.31	-242.0	0.5073
0.8000	3578.0	236.0	31.39	-153.7	0.6094
0.8300	18571.4	241.5	36.24	-193.8	0.7265
0.8400	16250.0	155.8	37.31	-198.7	0.6036
0.8770	16250.0	202.0	39.34	-172.9	0.7488
0.8870	9285.7	199.6	35.34	-191.7	0.7498
0.9170	8125.0	258.0	41.62	-226.9	0.7092
0.9230	15000.0	168.2	35.92	-258.4	0.6368
0.9530	13448.3	242.7	41.44	-216.2	0.6086
0.9930	4875.0	323.5	34.50	-153.5	0.7241
1.0030	19500.0	283.3	35.66	-240.0	0.6817
1.0330	10540.5	128.1	43.41	-116.3	0.6547
1.0330	5571.4	129.4	34.55	-161.0	0.6518
1.1070	5416.7	290.2	46.24	-118.6	1.0683
1.1830	10000.0	190.9	45.19	-97.0	0.7958
1.2300	4756.1	258.8	31.38	-197.4	1.0741
1.2770	8125.0	171.4	35.65	-161.0	0.6740
1.3330	12580.7	143.1	40.45	-144.2	0.5476
1.4430	17727.3	315.2	34.93	-830.7	0.7044
1.4870	6000.0	145.6	40.66	-93.1	0.6777
1.5230	13928.6	357.4	47.30	-205.5	0.7530
1.5700	26000.0	138.4	47.73	-104.2	0.3825
1.6330	16250.0	188.6	55.98	-117.5	0.6221
1.6700	11818.2	105.7	46.13	-141.0	0.8660
1.7230	8863.6	312.9	54.23	-117.2	0.7540
1.7630	11142.9	221.6	46.31	-139.8	0.5988
1.8200	12580.6	260.7	40.47	-199.3	0.6153

TABLE B1 DETAILS OF PROTOTYPE ELEMENTS

Action applied to element	Type of fastening *	Grading Modulus mean	Grading Modulus Coefficient of variation %	Moisture Content %	Dimensions x"	Dimensions y"	Label
Actions T_1 then T_2 then S (Series 1)	1	1.490	15.1	11.0	36.0	36.0	51
	2	1.482	15.8	10.9	"	"	11
	3	1.450	13.6	10.5	"	"	21
	2 + glue	1.423	14.8	10.4	"	"	31
	1	0.839	13.6	10.6	"	"	52
	2	0.916	14.0	10.9	"	"	12
	3	0.899	13.0	10.4	"	"	22
	2 + glue	0.960	11.2	10.5	"	"	32
	1	0.654	12.0	10.7	"	"	53
	2	0.643	10.0	10.7	"	"	13
	3	0.615	17.3	10.6	"	"	23
	2 + glue	0.651	11.6	10.8	"	"	33
Actions T_1 then T_2 then S (Series 11)	1	1.581	9.6	10.7	35.32	35.57	A5
	2	1.257	7.0	10.9	35.34	35.34	B1
	3	1.140	6.1	10.8	35.30	35.34	C2
	2 + glue	1.068	6.3	10.8	35.42	35.23	DG
	1	0.986	6.1	11.0	35.10	35.57	E5
	2	0.912	6.2	10.7	35.38	35.40	F1
	3	0.844	6.1	10.8	35.00	35.56	G2
	2 + glue	0.784	6.0	10.8	35.44	35.90	HG
	1	0.724	6.2	10.5	35.28	35.29	I5
	2	0.664	6.0	10.8	35.38	35.70	J1
	3	0.599	7.5	10.7	35.44	35.29	K2
	2 + glue	0.490	9.1	10.5	35.50	35.59	LG
Bending Action M_1	2 + glue	0.384	8.2	9.8	59.75	7.00	X1
	3	0.471	"	11.1	"	"	X2
	2	0.493	"	10.2	"	"	X3
	1	0.532	"	10.6	"	"	X4
	2 + glue	0.554	"	10.9	"	"	X5
	3	0.610	"	10.9	"	"	X6
	2	0.645	"	10.5	"	"	X7
	1	0.706	"	10.7	"	"	X8
	2 + glue	0.737	"	11.0	"	"	X9
	3	0.785	"	10.4	"	"	X10
	2	0.820	"	11.2	"	"	X11
	1	0.876	"	11.1	"	"	X12
	2 + glue	0.942	"	10.5	"	"	X13
	3	0.972	"	10.7	"	"	X14
	2	1.007	"	11.0	"	"	X15
	1	1.064	"	10.7	"	"	X16
	2 + glue	1.116	"	10.5	"	"	X17
	3	1.212	"	11.0	"	"	X18
	2	1.308	"	10.9	"	"	X19
	1	1.417	"	10.2	"	"	X20
	2 + glue	1.482	"	10.6	"	"	X21
	3	1.591	"	11.0	"	"	X22
	2	1.691	"	10.9	"	"	X23
	1	1.840	"	10.3	"	"	X24

Action applied to element	Type of fastening *	Grading Modulus mean	Grading Modulus Coefficient of variation %	Moisture Content %	Dimensions x"	Dimensions y"	Label
Bending Action M_2	2 + glue	0.445	8.2	10.2	7.00	59.75	Y1
	3	0.527	"	10.7	"	"	Y2
	2	0.527	"	10.8	"	"	Y3
	1	0.549	"	11.3	"	"	Y4
	2 + glue	0.575	"	10.6	"	"	Y5
	3	0.654	"	10.1	"	"	Y6
	2	0.680	"	10.6	"	"	Y7
	1	0.711	"	10.8	"	"	Y8
	2 + glue	0.981	"	11.4	"	"	Y9
	3	0.789	"	10.6	"	"	Y10
	2	0.841	"	10.4	"	"	Y11
	1	0.876	"	11.1	"	"	Y12
	2 + glue	0.911	"	10.6	"	"	Y13
	3	0.976	"	10.4	"	"	Y14
	2	1.007	"	10.7	"	"	Y15
	1	1.077	"	11.3	"	"	Y16
	2 + glue	1.099	"	10.9	"	"	Y17
	3	1.212	"	11.3	"	"	Y18
	2	1.299	"	10.8	"	"	Y19
	1	1.447	"	10.5	"	"	Y20
	2 + glue	1.491	"	10.7	"	"	Y21
	3	1.582	"	11.0	"	"	Y22
	2	1.609	"	10.8	"	"	Y23
	1	1.949	"	10.7	"	"	Y24
Torsional Action H	1	1.348	5.2	11.0	59.25	59.25	T1
	2	1.272	5.0	11.0	"	"	TL
	3	1.182	4.9	10.3	"	"	T3
	2 + glue	1.128	4.9	10.5	"	"	T4
	1	1.067	4.8	10.2	"	"	T5
	2	1.014	4.8	10.7	"	"	T6
	3	0.951	4.9	10.2	"	"	T7
	2 + glue	0.915	4.6	11.0	"	"	T8
	1	0.875	4.7	10.2	"	"	T9
	2	0.832	4.9	9.6	"	"	T10
	3	0.796	4.8	10.6	"	"	T11
	2 + glue	0.759	5.0	11.3	"	"	T12
	1	0.719	5.0	10.3	"	"	T13
	3	0.684	5.0	10.8	"	"	T14
	3	0.636	5.3	10.5	"	"	T15
	2 + glue	0.584	5.2	10.7	"	"	T16

* See Fig. 1.1

TABLE B2-DATA FROM TESTS ON PARTICLE BOARD ELEMENT-ACTION T_1

ACTION T_1 LB/IN	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (MICROSTRAIN) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-206.94	-218.5	51.8	-14.4	-178	-238	-166	-255	-260	-343	-130	-238	-174	-224	-208	-239	-247	-277	-200	-205	-155
-432.40	-462.0	106.3	-20.4	-390	-558	-317	-515	-470	-659	-317	-542	-364	-518	-407	-504	-474	-560	-425	-467	-348
-659.21	-714.4	163.6	-21.5	-599	-900	-477	-794	-667	-992	-518	-852	-556	-823	-610	-783	-698	-851	-657	-745	-563
-878.06	-961.8	221.0	-26.8	-787	-1243	-631	-1092	-847	-1311	-701	-1168	-752	-1123	-800	-1069	-905	-1135	-878	-1026	-774
-1102.87	-1223.8	279.8	-29.7	-963	-1653	-778	-1439	-1008	-1652	-881	-1515	-926	-1470	-989	-1391	-1107	-1457	-1091	-1344	-999
-663.59	-752.4	180.4	-25.3	-613	-975	-490	-861	-687	-1061	-531	-905	-578	-875	-629	-826	-719	-909	-684	-801	-587
-211.67	-252.4	72.5	-17.1	-199	-290	-180	-306	-293	-412	-151	-280	-191	-264	-237	-262	-274	-297	-227	-253	-181
-658.71	-733.7	176.6	-21.4	-611	-929	-489	-820	-681	-1016	-530	-870	-578	-840	-628	-801	-710	-872	-675	-780	-581
-1096.22	-1222.0	284.2	-25.8	-962	-1653	-773	-1444	-1008	-1667	-883	-1521	-920	-1466	-989	-1389	-1102	-1454	-1090	-1336	-1001
-658.83	-753.7	185.4	-27.8	-611	-980	-489	-864	-686	-1063	-530	-909	-569	-874	-629	-832	-718	-906	-681	-805	-588
-214.47	-263.4	79.5	-16.5	-207	-316	-180	-317	-300	-426	-158	-286	-194	-275	-243	-277	-281	-333	-238	-260	-193
-0.65	-22.6	22.8	-9.5	-14	-42	1	-45	-20	-48	-11	-26	-9	-26	-19	-11	-19	-36	-23	-36	-26

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15
-200	-182	-219	-258	-256	-222	-157	14	-23	41	28	37	37	24	18	86	65	80	59	83	56	93
-488	-382	-468	-546	-518	-478	-362	46	0	91	64	87	90	69	73	167	124	146	112	141	111	151
-789	-594	-751	-813	-774	-748	-578	100	45	148	111	144	142	129	149	236	173	210	164	194	163	196
-1089	-804	-1030	-1062	-1035	-1005	-802	155	101	207	163	196	207	190	212	291	228	274	222	243	221	241
-1418	-1021	-1325	-1309	-1320	-1264	-1040	217	164	264	232	249	271	251	274	346	276	328	274	290	285	290
-850	-614	-793	-846	-825	-775	-612	112	64	158	132	153	162	147	164	259	196	225	168	203	191	218
-260	-206	-249	-305	-294	-263	-174	33	-15	56	43	59	58	40	48	129	84	98	82	99	92	119
-817	-617	-767	-832	-799	-768	-586	104	57	151	140	147	166	136	161	250	190	218	184	201	190	206
-1407	-1019	-1319	-1304	-1312	-1255	-1039	220	172	266	236	253	277	253	289	353	275	324	281	295	299	288
-858	-613	-805	-845	-830	-777	-615	113	69	164	133	155	168	149	170	263	198	228	191	210	200	219
-268	-212	-263	-313	-310	-270	-187	33	-10	62	51	61	69	48	55	143	91	105	91	105	99	123
-35	-10	-20	2	-23	-26	-10	5	-1	18	21	9	19	23	33	46	7	25	28	21	31	30

Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
70	60	52	65	60	80	66	46	35	-95	-35	-102	-93	-82	-93	-98	-98	-6	-99	-59	-103	-50
109	119	106	132	126	145	133	106	93	-198	-90	-195	-199	-157	-199	-189	-251	-73	-222	-139	-215	-103
158	184	160	187	189	206	196	176	154	-281	-158	-285	-313	-233	-331	-272	-408	-148	-353	-227	-340	-167
211	240	215	238	254	269	262	236	219	-415	-217	-366	-420	-295	-465	-343	-572	-222	-481	-302	-460	-225
265	302	263	295	321	323	328	294	301	-521	-312	-450	-542	-361	-615	-404	-765	-295	-634	-379	-596	-291
183	191	175	199	209	222	220	197	171	-323	-161	-294	-320	-227	-349	-262	-432	-141	-357	-231	-355	-169
73	63	77	82	85	104	92	73	57	-107	-34	-108	-108	-76	-85	-105	-113	-5	-101	-67	-113	-45
182	172	177	191	204	212	225	186	174	-318	-146	-288	-309	-227	-320	-272	-414	-150	-351	-235	-349	-173
267	292	268	300	336	326	340	299	301	-515	-301	-443	-530	-356	-595	-409	-751	-286	-624	-382	-591	-288
194	186	186	198	215	223	229	196	181	-322	-158	-294	-321	-226	-346	-271	-432	-134	-344	-234	-350	-169
89	68	88	88	90	106	103	79	63	-108	-33	-112	-113	-82	-85	-104	-123	-2	-103	-71	-110	-49
27	18	24	20	17	27	31	30	27	-3	7	0	-8	-17	14	-26	-18	15	4	0	3	7

S14	S15	S16
-96	-47	-121
-203	-97	-262
-315	-158	-401
-437	-214	-535
-580	-278	-682
-335	-156	-421
-91	-45	-132
-313	-161	-391
-570	-277	-676
-340	-159	-417
-103	-48	-140
-3	-4	0

PARTICLE BOARD

TABLE B2 CONTINUED - ACTION S.

ACTION S LB/IN	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (MICROSTRAIN) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
22.32	-0.0	0.9	63.5	4	1	-1	5	-6	3	-4	-3	0	0	0	0	0	0	2	-4	-4
44.42	1.1	0.9	131.7	7	4	0	-1	10	0	-2	-5	-1	0	0	0	-1	1	0	0	-4
66.45	0.7	0.7	195.3	8	7	-2	0	7	0	0	-9	0	1	0	0	-5	1	4	-2	-8
88.60	0.2	1.6	263.3	10	9	0	-2	-1	5	-5	-13	-1	0	1	0	-1	3	1	-2	-12
110.51	0.2	2.1	329.5	10	11	-9	5	-4	-1	-10	-13	0	1	0	4	-5	3	3	-5	-13
22.25	-1.3	0.9	67.9	0	-1	0	0	-9	-3	-3	-2	0	-1	-3	0	-1	0	0	0	-3
110.52	-0.3	2.2	321.7	10	10	0	6	-13	5	-12	-14	1	0	-3	1	-3	3	5	-4	-14
22.15	0.2	1.1	72.3	0	0	0	5	0	0	0	-3	1	1	0	0	-1	0	1	1	-2

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15
1	0	0	0	1	1	4	-3	0	1	-1	-1	2	4	-4	0	2	-1	1	0	-1	0
0	0	0	0	3	4	8	-3	-5	0	0	0	4	2	-3	0	-2	-2	4	0	0	0
3	0	-3	-2	3	5	8	-1	0	-3	-1	-4	4	6	-6	-1	0	-7	3	0	-1	0
-3	-4	-4	1	3	7	14	-9	1	-1	1	-3	4	9	-7	0	0	-5	7	1	1	0
-4	-1	-1	0	5	7	24	-7	1	0	-1	-5	8	11	-9	0	0	-6	9	2	0	0
0	-4	-2	0	1	3	4	-1	0	0	2	0	2	3	-1	0	0	0	2	0	0	0
-6	-4	-4	0	5	9	20	-9	1	-3	-1	-4	7	12	-8	0	-1	-5	9	2	-1	0
-1	-1	-1	-1	1	1	6	-1	0	0	1	-1	3	1	0	-1	0	-1	3	1	0	-1

Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
2	1	3	1	2	0	0	3	5	28	16	28	29	30	12	39	21	25	25	32	28	23
-1	0	5	0	4	1	5	4	9	51	44	47	56	48	48	50	49	65	54	49	56	55
1	1	5	-1	2	-1	1	9	11	82	79	71	77	79	79	75	83	79	80	85	82	77
3	1	8	-5	5	-2	3	6	16	99	102	106	112	104	106	109	107	100	104	108	111	102
1	0	11	-2	4	-2	6	11	18	135	126	121	141	129	128	136	125	130	130	137	137	129
1	0	3	0	1	0	1	2	5	28	26	22	32	29	28	28	31	32	28	33	32	17
0	2	12	-1	3	-3	6	12	18	136	122	118	134	131	129	128	133	127	131	131	140	121
3	0	2	0	6	0	2	3	5	32	31	28	41	31	32	29	36	31	36	32	32	23

S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	S28	S29	S30	S31	S32
30	38	34	-26	-50	-34	-31	-28	-45	-36	-46	-49	-28	-35	-43	-27	-16	-30	-36
49	46	56	-78	-76	-81	-81	-80	-76	-67	-122	-74	-68	-85	-83	-63	-76	-83	-75
79	78	82	-116	-120	-118	-103	-111	-106	-117	-124	-130	-110	-112	-119	-113	-107	-112	-121
109	113	116	-149	-162	-150	-175	-152	-149	-155	-169	-175	-138	-158	-156	-148	-151	-146	-157
133	131	130	-192	-185	-211	-190	-191	-190	-193	-204	-217	-171	-204	-239	-186	-198	-196	-191
27	31	32	-35	-32	-48	-35	-33	-38	-51	-42	-45	-32	-41	-42	-35	-31	-34	-43
131	123	132	-187	-193	-202	-189	-193	-187	-184	-191	-210	-174	-195	-199	-188	-186	-189	-195
26	29	34	-44	-31	-49	-43	-46	-33	-32	-33	-45	-35	-47	-35	-42	-34	-45	-44

STOP 0
/&

TABLE B3. DATA FOR SERIES I COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS.

ELEMENT 51 UNDER ACTION T_2

STRESS T_2 lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-128.61	5.0	-131.9	47.3	0	17	-9	7	-2	1	-14	41	0	12	-2	10	-5	4	-6	35	3
-267.55	12.0	-264.9	59.0	13	27	-11	21	1	14	-23	51	1	26	0	20	-7	17	-11	61	0
-407.04	16.8	-391.6	67.4	9	44	-16	36	2	15	-31	56	0	45	-3	39	-9	22	-17	66	4
-546.29	17.0	-521.7	77.7	9	49	-22	50	6	20	-37	44	-3	48	-9	48	-13	21	-15	66	3
-408.51	11.5	-423.6	73.3	7	36	-19	36	6	9	-40	40	-2	39	-4	24	-12	6	-15	61	1
-129.35	12.4	-206.6	61.8	11	33	-1	20	11	12	-30	50	2	30	3	14	-3	14	-8	48	14
-407.97	17.3	-412.9	70.5	7	57	-13	38	9	4	-42	53	2	45	0	33	-7	20	-14	70	5
-547.14	20.6	-524.7	74.4	7	61	-22	53	9	25	-39	53	-1	54	-11	53	-21	25	-16	79	3
-407.97	17.0	-424.9	73.5	9	52	-17	46	12	22	-33	50	2	48	-6	40	-16	18	-17	69	2
-129.23	14.2	-206.5	59.0	12	40	-3	26	15	13	-27	48	3	29	4	20	-10	14	-10	60	11
-0.81	11.4	-78.6	30.4	9	33	1	18	18	10	-15	22	5	20	14	16	0	1	-10	34	15

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-7	0	-6	-4	11	-2	36	-67	-501	-122	-259	-97	-181	-116	-212	-7	-136	30	-89	16	-172
1	-2	0	-1	19	-2	73	-106	-807	-182	-493	-161	-337	-199	-424	-21	-279	39	-237	18	-399
19	-2	3	0	33	-1	87	-131	-1053	-215	-702	-197	-516	-244	-617	-31	-473	44	-452	48	-683
23	2	0	-5	33	-4	93	-130	-1299	-249	-930	-215	-719	-258	-845	-12	-730	90	-699	106	-1021
16	-1	-10	-2	25	-7	80	-101	-1120	-210	-760	-183	-557	-234	-674	-25	-536	60	-527	63	-789
12	2	-13	0	15	0	60	-72	-642	-169	-348	-146	-224	-168	-298	-70	-162	-1	-154	-18	-292
21	2	-1	-1	30	1	92	-108	-1082	-225	-732	-195	-542	-246	-647	-66	-495	33	-482	41	-744
35	-6	8	0	39	2	102	-117	-1293	-245	-926	-211	-727	-267	-851	-30	-714	82	-699	105	-1034
26	-3	-3	0	28	-6	87	-100	-1111	-211	-765	-187	-570	-236	-672	-46	-522	52	-526	60	-792
17	2	-8	6	17	-4	63	-80	-650	-167	-355	-153	-215	-175	-304	-68	-145	-9	-153	-13	-299
12	7	-7	10	9	9	36	-52	-284	-112	-110	-85	-31	-88	-85	-81	19	-55	-3	-54	-56

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-14	-161	9	-178	0	-137	2	-263	-51	-174	-40	-45	-4	-25	-54	-61	-78	-9	-65	-234	14
-22	-372	-22	-462	-43	-435	-31	-487	-95	-357	-86	-148	-21	-201	-77	-158	-122	-38	-67	-329	3
0	-597	-3	-740	-36	-697	-30	-715	-93	-600	-90	-263	-8	-365	-72	-288	-133	-101	-80	-385	-4
52	-877	24	-1002	-13	-994	-8	-959	-73	-867	-87	-347	13	-563	-56	-432	-135	-170	-99	-439	-3
21	-671	2	-842	-39	-771	-28	-759	-83	-683	-84	-300	-17	-401	-65	-312	-133	-115	-81	-403	-2
-35	-231	-43	-438	-80	-230	-52	-324	-72	-278	-72	-157	-62	-115	-80	-69	-99	-1	-57	-294	-17
3	-630	-7	-808	-44	-745	-28	-729	-88	-644	-90	-279	-32	-381	-91	-298	-127	-108	-84	-379	-20
53	-868	20	-1034	-10	-1009	-3	-966	-67	-887	-90	-347	4	-569	-61	-435	-129	-170	-93	-434	-3
17	-658	1	-854	-37	-770	-19	-755	-67	-706	-88	-300	-17	-394	-74	-318	-126	-118	-76	-399	-6
-32	-225	-47	-448	-83	-289	-30	-323	-65	-284	-75	-153	-67	-115	-90	-70	-96	3	-54	-277	-17
-57	-19	-66	-134	-106	-47	-63	-45	-64	-42	-51	-69	-73	0	-52	16	-28	39	-27	-120	-37

S12	S13	S14	S15	S16
-187	12	-181	-6	-68
-342	-3	-357	-22	-139
-498	-1	-543	-37	-238
-672	17	-758	-27	-340
-543	0	-614	-32	-265
-247	-22	-302	-24	-118
-527	-12	-593	-29	-249
-666	16	-770	-26	-341
-549	4	-629	-23	-270
-254	-14	-305	-21	-125
-51	-44	-98	-26	-5

TABLE B3 CONTINUED

ELEMENT 52 UNDER ACTION T_s

STRESS T_s lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-129.14	7.7	-228.4	4.2	5	15	10	5	5	6	5	-2	23	-1	1	10	7	6	-4	15	14
-267.09	12.2	-456.3	1.5	4	25	11	12	2	14	6	1	33	1	-1	24	14	17	-22	33	22
-407.15	15.9	-678.3	-2.5	4	33	14	19	3	25	10	0	48	-3	-7	26	22	18	-27	38	35
-545.21	16.1	-899.6	-8.1	9	41	12	26	-1	32	12	-6	57	-16	-10	28	27	20	-27	34	46
-409.15	7.6	-732.4	-15.2	2	34	19	17	0	22	10	-3	50	-166	-2	23	24	23	-25	29	26
-128.07	13.3	-338.3	-25.0	5	28	21	17	9	21	8	-1	31	-1	12	18	19	33	-14	16	-3
-407.07	15.2	-709.1	-6.2	1	33	19	17	3	20	11	-6	47	-7	0	27	29	22	-22	23	34
-545.67	18.9	-903.8	-9.1	3	39	15	21	2	25	18	0	58	-7	-1	35	29	30	-28	32	50
-406.80	16.5	-732.5	-19.8	4	34	20	21	4	27	9	-4	52	-8	0	28	25	34	-23	27	31
-128.22	11.5	-345.6	-22.1	0	28	20	13	7	18	4	1	33	-3	12	18	18	30	-12	5	-4
-1.07	8.3	-73.8	-13.3	-1	20	18	8	5	8	9	6	13	2	12	16	7	22	1	-9	-10

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
9	4	11	17	2	-8	24	-19	-269	-51	-426	-39	-228	34	-213	-9	-317	-15	-342	-13	-414
8	7	17	19	13	-14	39	-106	-514	-145	-803	-109	-501	12	-423	-72	-657	-63	-688	-62	-850
1	20	28	26	21	-20	43	-101	-804	-144	-1252	-72	-903	78	-658	-74	-1101	-51	-1115	-45	-1365
-13	32	22	24	24	-26	38	22	-1211	-4	-1782	73	-1408	255	-1114	44	-1683	108	-1714	135	-2016
-5	25	17	25	17	-22	36	-41	-929	-78	-1428	-2	-1045	163	-815	-30	-1278	27	-1293	37	-1564
9	20	15	21	10	-15	36	-95	-359	-119	-619	-76	-341	39	-302	-61	-489	-24	-492	-32	-636
-4	24	23	28	12	-17	43	-75	-898	-100	-1356	-32	-986	121	-783	-45	-1199	-11	-1239	-6	-1492
-6	33	27	26	27	-22	41	57	-1248	21	-1839	109	-1461	279	-1151	91	-1726	135	-1760	163	-2065
0	29	20	28	18	-23	38	-10	-935	-52	-1436	17	-1059	177	-825	-15	-1312	41	-1332	50	-1613
11	15	10	23	8	-14	27	-74	-385	-110	-637	-72	-362	40	-327	-67	-489	-26	-513	-32	-661
15	2	11	13	14	0	9	-52	-70	-59	-137	-55	-81	-8	-67	-48	-91	-29	-79	-21	-98

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-13	-531	-263	-241	-244	-380	-235	-398	-173	-296	11	-156	-31	-166	-41	-146	-94	-183	-103	-98	-76
-39	-1091	-467	-428	-423	-653	-444	-714	-346	-584	-5	-288	-116	-330	-100	-302	-127	-340	-170	-156	-139
0	-1723	-632	-615	-576	-936	-609	-1027	-451	-895	3	-462	-131	-525	-128	-497	-143	-525	-241	-214	-186
214	-2517	-729	-909	-651	-1264	-676	-1416	-473	-1325	31	-638	-33	-814	-61	-787	-128	-751	-290	-309	-152
119	-1951	-614	-718	-566	-1064	-576	-1184	-404	-1055	19	-537	-96	-614	-99	-600	-120	-626	-238	-256	-156
11	-800	-351	-312	-343	-526	-327	-579	-251	-462	19	-235	-101	-237	-114	-237	-97	-290	-118	-119	-113
71	-1888	-611	-677	-560	-936	-569	-1101	-397	-978	12	-522	-113	-594	-102	-566	-110	-581	-229	-236	-178
256	-2571	-708	-917	-631	-1295	-651	-1438	-450	-1334	42	-724	-20	-839	-40	-816	-114	-769	-286	-321	-139
138	-2022	-597	-713	-552	-1070	-551	-1173	-387	-1061	26	-552	-93	-630	-87	-612	-107	-630	-232	-256	-152
14	-816	-350	-337	-338	-542	-313	-589	-237	-489	12	-245	-89	-245	-95	-251	-98	-297	-124	-130	-109
1	-120	-77	-39	-84	-104	-79	-49	-99	-65	4	-57	-42	-31	-43	-33	-57	-50	-19	-22	-35

S12	S13	S14	S15	S16
-148	31	-242	-13	-156
-304	23	-502	-34	-307
-479	76	-790	-19	-503
-741	222	-1132	39	-785
-567	146	-905	17	-570
-216	54	-371	-3	-181
-537	105	-864	-4	-556
-767	240	-1157	53	-804
-569	160	-910	30	-567
-227	66	-374	-13	-135
-38	26	-41	-11	-38

TABLE B3 CONTINUED

ELEMENT 53 UNDER ACTION T_x

STRESS T_x N/m	MEAN VALUES ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-139.29	13.5	-300.7	40.1	-19	60	1	30	-20	37	15	45	-23	34	-9	33	-6	25	-21	26	0
-279.20	21.5	-509.2	54.9	-48	96	16	31	-26	62	29	49	-31	51	-12	57	1	31	-25	35	9
-418.34	25.8	-864.9	47.7	-86	127	22	31	-28	85	36	66	-44	61	-16	77	10	24	-25	48	14
-558.02	31.0	-1143.0	42.8	-111	159	33	26	-14	104	41	85	-54	62	-1	96	26	13	-30	56	19
-420.11	24.3	-924.8	19.7	-121	128	32	32	-22	76	50	70	-48	57	-5	90	23	8	-20	25	21
-139.99	11.5	-413.2	16.0	-83	54	14	26	-22	29	36	49	-24	35	-11	58	-2	4	-18	0	15
-418.65	24.8	-904.0	51.4	-105	125	24	33	-25	83	46	74	-38	64	-7	88	12	14	-22	30	18
-557.94	31.5	-1164.1	34.5	-117	151	35	22	-16	103	50	94	-49	69	0	102	22	8	-26	52	15
-419.89	24.8	-933.5	29.6	-115	124	33	25	-28	80	45	79	-43	61	-8	91	19	9	-24	25	19
-140.14	12.1	-422.1	14.2	-81	58	22	23	-26	29	36	49	-22	30	-11	61	-2	6	-15	-4	16
0.15	5.3	-80.9	-2.3	-38	0	20	-1	-8	5	11	22	17	15	-6	32	-13	0	2	-5	11

INDIVIDUAL VALUES OF STRAIN (microstrain)

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
25	-3	3	2	5	58	23	-315	-189	-467	-290	-436	-299	-298	-279	-246	-294	-153	-224	-157	-242
46	1	7	12	9	93	16	-700	-325	-896	-490	-804	-573	-538	-457	-501	-537	-353	-419	-395	-492
65	2	7	15	11	102	8	-1152	-429	-1369	-621	-1214	-745	-841	-624	-823	-671	-623	-526	-685	-640
81	14	1	20	8	117	-12	-1701	-467	-1897	-686	-1678	-865	-1220	-680	-1274	-630	-1051	-498	-1152	-632
58	8	1	16	7	101	-9	-1298	-415	-1602	-568	-1404	-709	-990	-561	-941	-526	-754	-418	-860	-546
16	8	-1	15	15	73	-12	-564	-306	-746	-339	-629	-356	-423	-228	-267	-359	-157	-285	-220	-365
55	11	-1	27	6	104	-24	-1306	-438	-1532	-595	-1342	-701	-565	-520	-923	-565	-710	-440	-804	-576
86	16	1	35	15	114	-33	-1788	-461	-1997	-643	-1793	-819	-1304	-596	-1382	-454	-1159	-382	-1293	-524
60	12	3	25	17	106	-24	-1435	-411	-1632	-561	-1435	-687	-1047	-504	-958	-492	-773	-412	-882	-527
18	2	-7	17	21	76	-8	-592	-303	-782	-340	-652	-349	-444	-223	-294	-332	-168	-281	-240	-367
9	5	0	30	19	11	-16	-170	-154	-214	-88	-126	-54	-51	57	7	-123	75	-90	6	-123

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-256	-192	-170	-189	-258	-512	-170	-495	-128	-451	-114	-28	-179	-6	-225	-51	-142	-90	-66	-73	-156
-546	-397	-400	-407	-579	-876	-427	-828	-363	-805	-222	-138	-397	-86	-414	-149	-216	-206	-161	-109	-407
-925	-525	-694	-552	-941	-1119	-750	-1063	-649	-1081	-332	-223	-659	-120	-646	-225	-316	-297	-279	-135	-663
-1467	-508	-1069	-637	-1405	-1194	-1167	-1235	-1062	-1270	-476	-268	-1046	-90	-957	-207	-450	-342	-430	-152	-1005
-1103	-399	-887	-479	-1212	-1083	-970	-1015	-815	-1037	-403	-184	-884	-63	-773	-168	-375	-301	-330	-136	-762
-338	-250	-380	-164	-530	-613	-367	-566	-215	-545	-194	-31	-364	-3	-305	-107	-200	-112	-138	-101	-206
-1022	-465	-818	-514	-1102	-1081	-892	-1027	-748	-1044	-377	-155	-788	-67	-722	-196	-358	-268	-336	-156	-724
-1594	-397	-1185	-579	-1508	-1215	-1284	-1182	-1156	-1223	-527	-263	-1135	-41	-1022	-172	-491	-320	-469	-158	-1069
-1124	-386	-907	-485	-1215	-1073	-973	-1020	-816	-1032	-401	-190	-881	-46	-779	-168	-377	-259	-347	-130	-781
-343	-242	-396	-176	-552	-599	-382	-573	-235	-546	-215	-42	-370	6	-319	-117	-201	-109	-143	-104	-215
6	-68	-112	-38	-146	-134	-62	-139	7	-124	-65	-63	-62	18	-28	-59	-37	-3	-47	-60	27

S12	S13	S14	S15	S16
-311	-98	-173	-10	-214
-507	-291	-284	-67	-378
-587	-515	-313	-130	-517
-589	-811	-300	-233	-599
-515	-627	-254	-144	-496
-359	-159	-176	-3	-254
-538	-596	-280	-146	-502
-511	-880	-268	-255	-584
-496	-641	-239	-159	-494
-354	-166	-178	-15	-266
-101	-10	-19	3	-43

TABLE B3 CONTINUED

ELEMENT 11 UNDER ACTION T_x

STRESS T_x lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-129.85	6.5	-114.8	27.3	9	54	6	11	-5	15	-5	20	6	-14	10	13	3	0	2	12	-7
-269.96	3.4	-242.0	21.3	14	58	14	4	-3	7	-11	10	19	-28	13	8	4	-6	-1	0	-1
-407.97	6.7	-360.0	21.0	10	72	17	12	-1	17	-16	11	29	-26	17	7	13	-8	7	-9	8
-547.76	11.1	-474.4	20.7	21	79	29	19	0	24	-22	25	36	-17	19	10	14	0	6	-8	4
-409.44	10.1	-368.6	27.7	21	79	33	15	-2	19	-26	22	27	-16	19	17	7	0	4	-3	0
-130.16	6.9	-146.8	36.6	20	48	25	17	-10	10	-22	11	9	0	11	11	2	-5	7	6	0
-407.47	7.0	-378.8	26.4	22	72	27	10	-2	19	-31	14	21	-17	13	9	11	-7	2	-7	3
-548.23	11.8	-488.7	21.8	25	81	26	17	2	26	-31	23	30	-13	25	19	17	-1	7	-5	7
-409.63	8.6	-378.8	26.4	24	75	28	12	2	21	-28	16	19	-15	16	13	9	-2	2	-3	0
-130.36	6.3	-153.4	40.1	20	53	22	13	-4	10	-25	6	6	-4	9	12	3	-9	4	-1	-2
-1.39	3.3	-34.9	-20.6	20	1	13	5	-4	0	-9	-5	6	-4	14	11	0	-12	10	-4	2

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-9	-2	-5	0	7	16	14	-118	-95	-122	-157	-96	-200	-61	-106	-74	-172	-61	-133	-22	-135
-29	1	-14	5	-5	20	2	-203	-192	-222	-305	-181	-394	-134	-240	-159	-366	-133	-261	-61	-291
-35	10	-20	17	-5	29	2	-285	-305	-307	-441	-254	-563	-188	-381	-239	-548	-192	-387	-97	-441
-27	7	-14	19	4	28	4	-354	-420	-400	-570	-325	-734	-244	-506	-310	-734	-243	-491	-133	-579
-22	7	-12	12	6	24	7	-269	-303	-296	-455	-248	-601	-163	-387	-230	-579	-183	-385	-82	-462
-13	2	-13	7	6	17	13	-94	-93	-110	-177	-114	-283	-62	-149	-55	-237	-71	-158	5	-174
-22	5	-14	13	-2	22	4	-292	-308	-318	-439	-273	-580	-191	-386	-234	-565	-189	-386	-85	-450
-31	11	-12	16	8	25	6	-362	-425	-403	-587	-335	-746	-263	-519	-310	-753	-238	-526	-132	-606
-27	5	-13	9	10	23	5	-282	-318	-310	-460	-202	-615	-183	-405	-232	-591	-180	-413	-77	-476
0	0	-5	6	7	12	16	-110	-101	-109	-183	-128	-289	-70	-156	-56	-244	-77	-184	11	-185
25	1	-6	7	7	0	1	-1	-30	-7	-18	-47	-61	-34	-22	33	-93	0	-64	23	-40

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-20	-130	-68	-192	-9	-165	2	-244	20	-220	-10	-29	-5	-72	-37	-85	-51	-44	-69	-41	-54
-48	-289	-181	-378	-84	-334	-31	-464	-13	-439	-76	-92	-55	-187	-67	-182	-67	-91	-102	-67	-98
-80	-446	-290	-536	-152	-500	-69	-648	-50	-631	-140	-148	-93	-295	-94	-266	-65	-133	-133	-109	-113
-101	-602	-396	-689	-224	-656	-114	-823	-103	-822	-189	-188	-155	-418	-147	-376	-79	-173	-191	-153	-150
-55	-466	-329	-548	-172	-522	-74	-685	-52	-674	-158	-139	-108	-308	-100	-273	-54	-129	-138	-115	-117
27	-162	-172	-245	-86	-224	-9	-320	-13	-311	-57	-64	-20	-66	-19	-75	-29	-49	-60	-32	-43
-58	-451	-323	-545	-181	-510	-87	-667	-70	-654	-169	-149	-101	-310	-105	-262	-65	-139	-144	-117	-112
-104	-625	-411	-712	-233	-664	-127	-853	-115	-840	-208	-200	-129	-408	-147	-377	-86	-187	-185	-179	-133
-52	-482	-340	-560	-185	-532	-86	-702	-74	-691	-175	-160	-99	-313	-103	-271	-60	-133	-140	-124	-101
30	-167	-181	-253	-103	-220	-15	-319	-25	-301	-60	-61	-3	-63	-24	-62	-27	-49	-63	-27	-36
17	-17	-78	-65	-36	-57	-8	-25	-64	-47	-23	-124	47	-60	33	-24	24	-58	-16	21	-10

S12	S13	S14	S15	S16
-125	-22	-132	33	-95
-209	-48	-250	20	-191
-279	-74	-369	17	-239
-355	-108	-497	-3	-364
-299	-64	-403	9	-317
-168	0	-196	5	-125
-278	-67	-385	1	-297
-361	-89	-501	-25	-339
-310	-56	-407	-15	-324
-165	7	-200	-9	-139
14	-33	47	-71	26

TABLE B3 CONTINUED

ELEMENT 12 UNDER ACTION T_s

STRESS T_s lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-128.65	7.6	-164.4	38.8	11	24	4	25	3	1	1	-9	-11	15	4	16	6	10	13	7	12
-268.02	11.95	-360.3	57.4	21	29	0	25	8	6	12	-17	-6	37	10	23	0	9	19	-3	23
-408.01	19.7	-545.7	71.1	33	32	12	41	5	9	18	-17	0	59	19	38	7	13	24	-1	35
-547.49	24.8	-732.0	90.8	37	37	18	46	11	10	25	-15	7	76	24	52	7	14	35	-4	39
-408.28	17.6	-565.6	64.7	27	24	12	38	-10	0	17	-22	3	64	22	50	4	9	31	-8	39
-129.62	9.0	-223.4	4.1	16	22	7	28	-2	-15	15	-16	2	42	10	32	-3	4	20	-5	25
-408.12	19.8	-563.0	62.7	38	34	16	49	6	0	25	-22	2	64	22	40	5	4	31	-15	40
-547.22	28.4	-735.2	91.8	43	42	25	59	5	12	32	-14	3	78	23	50	14	13	38	0	45
-408.94	18.5	-573.0	62.8	34	31	15	47	7	-3	24	-24	0	62	13	35	6	6	35	-12	46
-129.27	8.7	-231.2	-1.4	14	28	8	31	-1	-9	16	-18	1	43	3	21	-7	1	16	-6	29
-1.04	3.4	-54.8	-45.5	-5	3	8	23	1	-27	19	-8	9	11	3	8	-6	-4	11	-9	21

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
9	-5	4	3	13	-10	25	-201	-162	-151	-138	-133	-102	-211	-206	-118	-157	-90	-105	-102	-176
-5	0	14	14	17	-4	48	-437	-276	-354	-272	-325	-221	-454	-397	-347	-334	-242	-178	-278	-339
0	2	20	19	19	4	71	-692	-377	-561	-375	-525	-324	-706	-537	-509	-469	-415	-222	-468	-471
-8	6	26	27	27	11	82	-926	-471	-779	-474	-740	-419	-959	-658	-732	-574	-611	-265	-684	-592
-5	0	10	17	22	0	73	-698	-398	-557	-379	-534	-318	-719	-565	-539	-490	-434	-204	-484	-478
-12	-6	0	0	11	-12	49	-276	-215	-139	-167	-149	-126	-285	-323	-181	-254	-94	-72	-106	-213
-5	1	20	18	23	2	72	-697	-390	-566	-376	-536	-341	-727	-572	-535.	-486	-426	-219	-475	-476
-5	5	33	29	35	19	88	-934	-478	-777	-468	-744	-415	-977	-680	-746	-579	-615	-264	-683	-583
-15	6	11	18	17	3	76	-705	-402	-565	-377	-541	-326	-732	-583	-549	-498	-436	-207	-487	-489
-10	-4	-1	2	11	-12	52	-285	-210	-154	-163	-158	-123	-290	-324	-199	-261	-118	-76	-115	-213
-3	4	-7	-3	5	-6	32	-74	-69	12	-19	-8	-12	-94	-119	-57	-115	3	11	14	-44

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-101	-163	-56	-217	-66	-326	-101	-265	-44	-285	-41	-48	-55	-87	-62	-32	-101	-97	-84	-94	-72
-254	-311	-184	-432	-244	-634	-258	-541	-147	-579	-95	-130	-160	-209	-160	-93	-186	-167	-175	-111	-191
-420	-469	-341	-600	-441	-887	-440	-783	-264	-874	-173	-197	-297	-289	-274	-131	-253	-220	-240	-134	-318
-614	-597	-507	-755	-658	-1108	-637	-984	-414	-1141	-241	-253	-432	-349	-420	-174	-341	-272	-321	-183	-436
-418	-471	-381	-602	-501	-953	-459	-824	-265	-932	-156	-204	-326	-284	-295	-141	-279	-239	-234	-142	-309
-85	-234	-147	-265	-215	-491	-143	-393	-30	-387	-84	-117	-123	-109	-79	-60	-172	-160	-85	-49	-88
-423	-501	-373	-613	-483	-926	-458	-805	-265	-877	-175	-221	-312	-286	-284	-132	-280	-243	-240	-138	-309
-614	-597	-523	-745	-675	-1115	-644	-987	-401	-1134	-242	-249	-439	-347	-431	-161	-347	-281	-322	-181	-442
-421	-494	-394	-614	-504	-949	-472	-834	-260	-929	-188	-205	-334	-283	-306	-148	-286	-254	-239	-142	-317
-85	-240	-161	-274	-226	-502	-149	-404	-31	-399	-91	-127	-128	-104	-84	-56	-175	-164	-87	-50	-85
6	-86	-63	-65	-111	-163	-36	-127	35	-65	-46	-101	-52	-32	-14	-19	-94	-74	2	15	9

S12	S13	S14	S15	S16
-116	-85	-148	-24	-155
-195	-218	-270	-75	-356
-273	-333	-382	-111	-535
-328	-462	-491	-172	-729
-277	-319	-424	-102	-604
-134	-70	-207	0	-269
-278	-320	-403	-103	-572
-331	-470	-430	-170	-738
-281	-322	-427	-150	-609
-138	-65	-199	12	-275
-33	24	-19	22	-37

TABLE B3 CONTINUED

ELEMENT 13? UNDER ACTION T_s

STRESS T_s lb/in	MEAN VALUES ϵ_{x}	ϵ_{y}	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
				INDIVIDUAL VALUES OF STRAIN (microstrain)																
-123.19	11.1	-248.8	22.9	34	27	8	-9	16	-7	10	8	30	31	19	2	10	-10	44	-34	0
-267.74	16.5	-504.2	11.7	51	40	16	-24	30	-13	23	14	56	47	39	2	34	-15	81	-89	5
-406.57	19.1	-780.4	-0.5	63	48	25	-36	41	-15	34	13	79	56	57	0	53	-27	108	-139	1
-544.52	24.5	-1009.2	-4.5	73	72	43	-39	50	-17	39	9	97	66	92	-7	76	-32	137	-174	5
-407.68	16.4	-786.1	0.2	65	49	37	-45	44	-19	33	3	90	57	72	-10	94	-38	118	-169	9
-127.03	10.6	-320.2	-6.6	44	24	32	-11	35	-19	21	-22	59	44	43	-6	33	-23	74	-112	6
-406.92	21.9	-777.3	-7.5	71	59	42	-39	51	-17	40	5	87	63	73	-7	61	-36	125	-155	10
-546.25	27.2	-1021.1	-0.0	77	69	55	-44	61	-20	47	12	108	60	100	-6	83	-40	147	-174	13
-407.42	21.0	-793.0	-0.7	65	61	47	-40	57	-18	40	2	95	58	79	-4	65	-43	132	-168	17
-124.41	15.0	-321.0	-1.5	45	23	40	-9	47	-17	24	-18	62	46	49	0	35	-20	85	-106	10
-2.34	3.1	-87.4	-10.9	34	14	36	4	43	-20	21	-20	47	34	36	-2	20	-11	58	-57	10

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
30	-18	14	13	0	27	19	-544	-139	-385	-225	-139	-342	-2	-612	-302	-207	-201	-243	-105	-232
32	-23	17	34	-5	31	11	-954	-174	-722	-397	-311	-707	-58	-1091	-645	-373	-456	-485	-277	-458
29	-33	27	62	-13	36	-12	-1362	-200	-1072	-579	-497	-1029	-151	-1463	-1038	-460	-789	-638	-543	-626
24	-37	29	72	-17	37	-23	-1769	-185	-1458	-717	-724	-1288	-289	-1768	-1567	-413	-1262	-668	-919	-692
-3	-22	7	65	-25	42	-25	-1450	-152	-1121	-600	-590	-1090	-125	-1523	-1156	-344	-897	-615	-585	-606
-11	2	-5	33	-12	42	-21	-735	-48	-487	-304	-145	-519	88	-813	-463	-144	-282	-319	-66	-308
16	-16	15	63	-15	43	-21	-1375	-171	-1106	-592	-519	-1056	-143	-1483	-1133	-409	-851	-626	-562	-629
18	-25	22	69	-21	41	-22	-1732	-202	-1471	-732	-740	-1306	-286	-1772	-1614	-419	-1280	-666	-926	-685
0	-19	6	73	-25	49	-28	-1451	-154	-1127	-596	-503	-1095	-122	-1531	-1193	-359	-914	-614	-568	-602
-7	9	3	37	-12	-7	-22	-753	-37	-485	-306	-137	-526	95	-819	-468	-133	-281	-320	-60	-318
1	18	0	25	-231	25	-14	-406	30	-159	-86	-21	-154	60	-203	-212	19	-96	-50	35	-56

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-72	-206	-143	-304	-84	-292	-133	-230	-206	-207	-136	-47	-209	-91	-70	-129	-14	-200	-275	-46	-16
-277	-441	-301	-639	-204	-590	-355	-457	-462	-402	-250	-155	-419	-226	-146	-317	-16	-371	-482	24	-101
-380	-640	-520	-733	-437	-695	-655	-596	-733	-544	-379	-237	-693	-300	-282	-448	-50	-506	-656	72	-212
-868	-750	-824	-1202	-700	-837	-1070	-675	-1224	-567	-540	-269	-1079	-273	-470	-516	-107	-618	-853	116	-361
-554	-627	-621	-1057	-459	-755	-769	-527	-872	-509	-417	-236	-904	-264	-305	-435	-37	-540	-697	107	-231
-64	-263	-312	-607	-122	-372	-217	-203	-234	-197	-196	-154	-317	-132	-64	-214	43	-274	-350	73	-47
-531	-641	-597	-1345	-442	-772	-730	-549	-829	-510	-399	-255	-761	-276	-258	-458	-44	-510	-674	106	-224
-890	-764	-865	-1187	-723	-884	-1412	-621	-1241	-565	-543	-260	-1099	-267	-480	-514	-106	-608	-853	120	-365
-574	-634	-654	-1037	-459	-766	-771	-525	-872	-434	-422	-245	-922	-260	-309	-441	-27	-534	-703	126	-234
-73	-272	-320	-610	-120	-379	-219	-139	-239	-199	-189	-134	-321	-142	-52	-220	59	-269	-349	94	-46
2	-28	-224	-277	-50	-97	-94	18	-63	7	-73	-99	-136	-30	-11	-45	19	-43	-120	53	0

S12	S13	S14	S15	S16
-250	-56	-222	-37	-130
-437	-208	-412	-31	-240
-586	-406	-586	-159	-427
-693	-632	-719	-220	-375
-585	-476	-643	-155	-326
-281	-109	-349	-54	-130
-568	-455	-614	-152	-327
-671	-732	-712	-224	-401
-580	-510	-642	-151	-327
-287	-123	-353	-23	-131
-65	-47	-114	-14	-16

TABLE B3 CONTINUED

ELEMENT 21 UNDER ACTION T_2

STRESS T_2 lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-128.53	-3.7	-104.8	10.9	1	7	-6	-1	2	-1	-4	-4	-8	-7	-6	-4	-9	-1	0	-9	-18
-266.86	2.0	-210.3	17.5	17	12	-5	0	-2	4	2	-1	-10	3	-9	2	-4	5	-1	0	-16
-406.73	6.7	-326.1	24.4	15	19	-4	5	-2	3	2	4	-3	19	-1	13	-1	9	-5	8	-21
-545.56	9.2	-447.3	30.9	19	29	-7	12	-1	11	0	14	-3	32	-11	26	-3	10	-9	13	-28
-408.26	5.4	-341.1	24.4	20	22	-7	4	-4	9	-3	2	-7	25	-5	15	-3	5	-8	2	-22
-129.91	1.1	-113.4	23.5	11	22	-7	1	-10	5	-7	0	2	2	-3	10	-4	-1	-6	3	-16
-407.07	6.3	-335.7	24.3	8	26	-12	12	-7	9	-1	9	-2	27	-13	25	-2	9	-11	13	-29
-545.56	7.8	-448.6	28.5	17	26	-10	8	4	8	2	7	-2	23	-8	20	-5	8	-8	6	-28
-407.46	6.5	-338.6	25.4	14	24	-9	4	-2	6	0	8	-2	31	-9	17	-1	10	-8	3	-22
-129.68	2.6	-116.7	17.1	7	27	-8	5	-6	9	-6	5	3	5	-1	13	-3	2	-4	3	-16
-1.69	0.0	-9.3	12.1	2	23	-4	-2	-3	-1	-6	3	0	-4	-3	11	-2	2	-1	6	-3

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-13	-2	-10	-5	-2	23	-4	-85	-96	-75	-115	-38	-100	-28	-154	-76	-112	-54	-120	-67	-121
-3	11	-2	1	7	14	5	-182	-181	-184	-199	-98	-164	-67	-359	-171	-178	-123	-223	-151	-232
-1	21	5	5	11	42	19	-283	-283	-287	-302	-172	-280	-36	-539	-268	-267	-190	-329	-240	-363
9	25	6	0	18	42	14	-340	-391	-389	-428	-239	-380	-142	-699	-376	-365	-206	-429	-339	-480
-7	20	-1	1	11	44	14	-303	-236	-290	-315	-177	-292	-83	-574	-282	-284	-135	-338	-250	-354
-24	3	5	0	7	21	5	-107	-87	-76	-108	-40	-87	17	-268	-91	-94	-52	-108	-60	-100
-1	17	6	0	12	37	16	-243	-279	-289	-304	-181	-281	-91	-557	-281	-269	-198	-312	-247	-358
1	30	6	1	13	40	21	-342	-397	-386	-422	-244	-393	-133	-713	-377	-366	-276	-444	-336	-477
0	12	4	1	17	42	12	-298	-294	-277	-324	-172	-287	-58	-591	-285	-275	-203	-334	-251	-364
-16	-2	2	0	8	31	2	-107	-89	-69	-111	-33	-94	20	-273	-97	-90	-58	-116	-60	-108
-21	-3	-5	0	0	12	0	-9	7	14	2	23	12	35	-91	-30	-2	-11	6	-11	22

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-74	-114	-96	-129	-23	-142	-49	-192	-35	-213	-55	-65	-34	-56	-12	-49	1	-126	-45	-27	-59
-179	-235	-207	-247	-79	-253	-115	-363	-114	-392	-143	-117	-92	-98	-45	-76	3	-227	-74	-31	-129
-264	-366	-339	-350	-149	-370	-204	-521	-206	-575	-242	-136	-132	-152	-75	-111	17	-329	-108	-49	-191
-367	-502	-440	-431	-235	-501	-308	-734	-319	-748	-332	-246	-187	-205	-124	-158	10	-413	-150	-79	-253
-269	-377	-363	-310	-169	-315	-217	-560	-234	-604	-262	-189	-135	-144	-76	-115	20	-353	-109	-48	-205
-64	-119	-127	-143	-40	-167	-49	-231	-81	-254	-98	-75	-19	-35	7	-28	20	-190	-51	-3	-102
-267	-391	-369	-331	-162	-391	-211	-542	-235	-609	-261	-202	-123	-157	-75	-113	12	-345	-112	-47	-209
-367	-537	-484	-427	-233	-500	-310	-702	-318	-757	-337	-261	-192	-214	-119	-164	13	-430	-144	-83	-263
-270	-381	-365	-340	-166	-336	-201	-557	-228	-605	-265	-208	-126	-155	-72	-112	16	-360	-106	-54	-210
-63	-116	-134	-135	-46	-115	-53	-225	-90	-253	-102	-31	-19	-49	0	-32	17	-191	-57	-2	-99
-5	12	-47	-77	-3	-21	-5	-24	-48	-35	-36	-43	16	9	13	3	11	-63	-12	22	-71

S12	S13	S14	S15	S16
-56	-56	-91	-21	-109
-106	-123	-166	-53	-206
-161	-186	-253	-101	-309
-213	-257	-345	-151	-407
-168	-197	-257	-36	-328
-65	-62	-81	-36	-150
-163	-193	-253	-109	-321
-216	-253	-349	-151	-436
-172	-195	-262	-103	-340
-56	-53	-89	-23	-156
-5	-13	5	-32	-37

TABLE B3 CONTINUED

ELEMENT 22Y UNDER ACTION T_x

STRESS T_x lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-128.27	10.0	-140.9	55.7	21	31	21	2	-6	4	-12	-6	26	25	6	20	3	12	-2	11	-17
-266.90	15.0	-308.8	93.7	23	38	30	0	-6	0	-15	-15	58	49	22	26	2	9	-17	12	-24
-406.50	19.6	-487.2	114.0	29	43	41	1	-9	2	-18	-21	74	60	36	34	2	10	-28	19	-27
-547.15	18.9	-681.3	128.6	20	33	51	-4	-8	-12	-24	-35	90	68	43	37	1	1	-32	18	-27
-408.12	18.1	-505.0	107.8	24	33	42	-3	-12	-9	-21	-31	82	65	41	36	6	3	-25	16	-30
-130.55	14.3	-165.8	70.1	22	36	69	6	-18	0	-7	-19	44	46	22	21	10	10	-10	-4	-28
-407.35	19.8	-498.7	110.8	21	43	36	-1	-11	-1	-21	-23	75	63	37	34	8	10	-22	19	-27
-548.50	25.3	-677.5	125.1	34	46	61	2	-5	-7	-21	-29	95	67	51	36	3	0	-27	30	-18
-409.01	21.6	-506.6	117.5	27	48	51	4	-6	-2	-19	-30	79	63	41	38	6	3	-25	14	-26
-129.50	13.0	-166.2	66.8	25	32	50	1	-13	-6	-11	-19	41	37	21	18	9	1	-9	-3	-24
-1.43	10.5	-6.3	30.7	15	19	35	2	-9	-2	-2	-10	14	27	8	17	8	5	0	1	0

INDIVIDUAL VALUES OF STRAIN (microstrain)

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-10	-1	10	13	29	11	43	-188	-47	-193	-82	-199	-73	-219	-81	-215	-75	-213	-83	-206	-59
-21	-4	11	25	50	22	84	-390	-136	-398	-195	-416	-202	-447	-208	-408	-184	-443	-199	-418	-134
-23	-6	12	39	62	34	100	-602	-226	-595	-300	-654	-334	-708	-334	-653	-283	-708	-299	-671	-103
-22	-5	10	51	65	57	98	-873	-295	-866	-393	-960	-444	-1030	-434	-984	-324	-1053	-314	-1003	-159
-28	-3	7	45	54	37	104	-635	-223	-644	-297	-710	-349	-797	-336	-689	-257	-769	-268	-717	-130
-41	0	5	31	35	29	86	-207	-58	-226	-94	-249	-124	-336	-114	-220	-82	-263	-93	-225	-3
-20	-3	11	40	69	35	101	-615	-222	-631	-298	-687	-338	-765	-332	-690	-261	-749	-261	-708	-136
-11	1	17	53	78	43	105	-868	-293	-859	-378	-962	-444	-1047	-416	-1004	-303	-1069	-308	-1010	-136
-24	0	15	45	70	36	105	-635	-229	-639	-307	-701	-359	-803	-337	-703	-246	-780	-260	-726	-114
-43	5	4	32	41	35	86	-207	-54	-220	-102	-245	-130	-333	-110	-213	-74	-264	-74	-224	-8
-18	11	9	13	24	30	46	0	0	-16	-10	-24	-18	-110	-5	-10	17	-23	20	4	53

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-212	-23	-140	-103	-132	-120	-169	-93	-181	-51	-36	-61	-63	-34	-73	59	-54	-8	-55	6	-171
-441	-78	-286	-235	-297	-276	-353	-212	-420	-111	-100	-172	-165	-106	-154	78	-110	-42	-119	0	-372
-720	-106	-488	-356	-503	-400	-564	-317	-668	-134	-172	-285	-303	-172	-259	83	-164	-67	-186	-12	-559
-1099	-53	-749	-455	-751	-484	-855	-380	-999	-219	-255	-367	-483	-228	-472	118	-257	-93	-281	-30	-801
-746	-51	-542	-332	-544	-388	-648	-280	-769	-132	-175	-281	-338	-175	-327	109	-175	-73	-206	-6	-591
-166	30	-190	-100	-197	-133	-265	-84	-305	-7	-43	-119	-75	-34	-74	104	-62	-15	-94	18	-211
-748	-52	-537	-359	-531	-391	-624	-293	-739	-140	-177	-293	-323	-166	-311	116	-182	-77	-205	-12	-580
-1101	-41	-766	-416	-765	-473	-868	-261	-1009	-194	-251	-366	-493	-228	-489	130	-246	-91	-294	-23	-823
-750	-34	-566	-325	-555	-376	-661	-277	-783	-127	-178	-277	-339	-175	-333	114	-173	-69	-226	-10	-612
-165	39	-191	-106	-139	-140	-263	-102	-317	-10	-36	-117	-82	-38	-73	96	-53	-20	-94	25	-208
59	57	-43	0	-37	2	-64	13	-86	49	9	-42	15	14	22	66	4	20	-17	30	-17

S12	S13	S14	S15	S16
-54	-177	-117	-92	9
-118	-368	-224	-233	0
-164	-556	-309	-368	-17
-185	-778	-308	-555	-18
-143	-583	-257	-429	10
-70	-215	-91	-170	25
-144	-584	-248	-424	-4
-160	-782	-274	-567	-7
-142	-598	-235	-453	8
-68	-216	-73	-173	25
-2	-32	9	-69	16

TABLE B3 CONTINUED

ELEMENT 23 UNDER ACTION T_L

STRESS T_L lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-129.37	6.0	-205.4	42.7	62	51	-7	2	-13	-5	4	9	27	36	-14	3	-14	-15	4	-13	52
-267.63	14.1	-448.1	60.5	117	95	4	-2	-10	-15	-2	9	64	44	-7	3	-6	-9	4	-20	72
-408.90	24.3	-707.1	73.4	143	127	32	0	12	-7	-7	7	86	53	-1	5	6	2	7	-26	93
-547.53	35.1	-963.9	84.4	154	144	51	2	44	-9	-16	10	105	68	3	7	25	16	2	-7	108
-407.38	27.0	-731.8	72.1	146	133	36	-4	29	-10	-11	3	92	59	-1	2	17	8	1	-19	95
-130.35	18.9	-249.6	32.6	117	53	17	8	13	4	-6	5	58	55	-2	3	8	11	3	0	60
-408.35	32.9	-714.5	68.1	144	141	39	14	25	2	-10	9	90	68	0	12	16	13	11	-3	98
-548.61	38.4	-973.9	85.6	152	142	40	4	51	-7	-18	7	112	74	1	11	33	16	9	-15	117
-409.32	33.0	-731.2	165.0	146	145	37	7	39	-11	-11	4	97	81	-5	12	21	15	3	-16	100
-131.17	21.3	-255.2	49.2	127	26	15	10	20	1	-2	0	63	58	-10	8	13	15	1	-6	59
-1.08	16.8	-35.2	16.5	87	21	13	13	26	14	0	-8	30	19	7	21	24	29	3	1	16

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-2	1	-20	12	-7	0	-4	-345	-116	-254	-84	-243	-98	-238	-327	-308	-95	-214	-36	-198	-56
-23	18	-34	33	-5	-1	9	-703	-227	-611	-212	-574	-735	-625	-591	-664	-188	-534	-94	-469	-137
-40	45	-47	72	1	0	18	-1168	-265	-1048	-323	-955	-353	-1015	-781	-1142	-235	-961	-102	-834	-170
-38	73	-49	94	8	-5	39	-1730	-237	-1577	-361	-1430	-425	-1464	-888	-1789	-90	-1542	54	-1339	-49
-55	54	-48	75	0	0	36	-1276	-192	-1195	-276	-1101	-327	-1110	-741	-1279	-135	-1091	12	-960	-75
-53	16	-32	37	11	4	26	-445	-36	-430	-32	-363	-77	-434	-324	-348	-61	-326	64	-308	5
-39	53	-40	[illegible]	13	6	37	-1235	-204	-1143	-273	-1089	-310	-1087	-737	-1225	-149	-1041	-10	-913	-84
-35	50	-50	115	11	1	48	-1757	-231	-1595	-360	-1529	-416	-1521	-884	-1834	-59	-1580	85	-1381	-32
-57	57	-36	66	21	7	56	-1302	-167	-1178	-256	-1116	-317	-1119	-764	-1310	-97	-1115	52	-986	-41
-48	15	-22	-1	24	2	59	-485	-31	-450	-29	-368	-70	-421	-358	-404	-54	-333	62	-331	11
-20	1	-1	46	25	14	37	-73	27	-107	16	-82	14	-103	-47	-38	-13	-67	52	-70	55

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-222	-237	-387	-155	-163	1	-139	-115	-248	-278	-200	-76	-166	12	-125	-14	-27	-205	-170	-35	-204
-471	-404	-832	-248	-430	-74	-542	-293	-465	-498	-378	-177	-366	-14	-301	-29	-52	-368	-349	-45	-468
-798	-496	-1331	-377	-770	-110	-691	-439	-759	-612	-566	-223	-680	10	-529	-13	-92	-478	-529	-42	-757
-1246	-445	-1917	[illegible]	-1174	-6	-1144	-378	-1176	-622	-764	-206	-1105	142	-880	58	-176	-538	-749	-16	-1128
-856	-419	-1608	[illegible]	-320	-27	-776	-359	-823	-642	-635	-194	-808	67	-608	41	-109	-453	-576	-12	-823
-274	-209	-662	-135	-240	35	-156	-140	-251	-330	-306	-144	-275	62	-154	52	-38	-188	-231	17	-270
-850	-424	-1452	-324	-970	-46	-747	-355	-798	-567	-602	-202	-766	64	-552	54	-102	-450	-551	-15	-794
-1279	-406	-1970	[illegible]	-1311	6	-1174	-358	-1205	-571	-407	-201	-1150	172	-955	75	-182	-530	-771	-8	-1157
-479	-348	-1361	-275	-376	3	-741	-315	-355	-525	-666	-153	-638	140	-177	143	-140	-437	-559	-13	-825
-263	-144	-702	-146	-277	16	-156	-123	-262	-304	-312	-141	-274	85	-169	104	-39	-199	-241	29	-290
-32	4	-220	[illegible]	-40	-31	15	-10	17	-50	-60	-77	-63	41	11	95	-15	-3	-45	27	-47

S12	S13	S14	S15	S16
-44	-165	-151	[illegible]	-222
-79	-387	-401	[illegible]	-384
-33	-424	-397	-140	-454
-27	-930	-385	[illegible]	-537
-37	-649	-367	[illegible]	[illegible]
7	-222	-155	[illegible]	-244
-43	[illegible]	-470	[illegible]	[illegible]
-18	-761	-377	[illegible]	-422
-31	-646	-474	-150	-530
-7	-245	-219	-33	[illegible]
7	-29	-43	[illegible]	[illegible]

TABLE B3 CONTINUED

ELEMENT 31 UNDER ACTION T_x

STRESS T_x lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-131.26	0.3	-81.2	12.4	-4	-14	1	1	-2	-5	1	15	-12	13	4	14	6	-2	-1	-1	-3
-264.59	4.5	-180.7	22.3	-13	4	2	8	0	9	-1	23	-9	31	7	23	8	6	-12	1	-6
-407.07	6.1	-281.4	30.1	-13	5	6	14	0	0	0	42	-6	41	8	30	8	6	-21	-4	-6
-545.49	8.8	-391.3	37.5	-13	12	10	12	0	11	2	47	0	54	16	34	10	3	-26	-11	-7
-409.38	7.5	-286.2	31.9	-10	6	11	9	0	8	3	42	0	40	11	30	12	0	-19	-4	-2
-131.10	6.4	-75.8	14.3	-7	7	7	4	9	1	5	20	0	21	15	14	12	7	-2	-17	4
-407.76	8.5	-277.9	29.4	-11	12	11	13	3	8	6	43	1	34	14	32	11	5	-18	-12	0
-546.25	11.5	-382.6	43.3	-14	17	14	17	3	18	4	54	1	51	12	39	15	.1	-23	-10	0
-408.15	11.0	-279.6	25.5	-9	12	14	16	4	13	5	51	1	39	15	32	15	7	-19	-8	2
-131.22	8.5	-73.3	7.6	-7	9	4	6	5	4	11	29	2	13	8	17	14	10	2	-14	6
-2.09	5.3	15.5	-1.6	1	0	4	1	6	-1	5	12	8	-5	6	7	9	7	7	-9	10

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
10	4	6	-1	-3	-7	0	-27	-157	-11	-169	7	-178	29	-165	-23	-147	-7	-157	4	-182
31	1	9	-1	-20	-3	4	-104	-260	-62	-312	-9	-352	24	-305	-64	-309	-26	-317	0	-359
42	0	13	-3	-17	--	11	-176	-385	-117	-455	-41	-511	-1	-451	-93	-461	-30	-482	4	-527
56	1	13	-3	-26	-3	15	-266	-527	-163	-594	-62	-680	-32	-623	-101	-665	-15	-675	35	-742
42	1	9	-1	-22	-1	14	-172	-413	-94	-469	-15	-547	20	-485	-73	-494	-8	-509	33	-569
22	7	6	7	-10	4	22	-11	-160	12	-196	47	-212	69	-175	-2	-174	20	-177	39	-207
44	6	3	0	-20	-2	16	-171	-396	-99	-462	-19	-523	22	-464	-72	-478	-11	-495	30	-541
53	9	13	-2	-21	-1	24	-257	-532	-148	-597	-52	-680	-16	-614	-92	-674	-3	-680	43	-740
46	8	10	-1	-16	0	22	-158	-402	-92	-463	-10	-535	26	-478	-63	-496	1	-506	48	-558
26	9	13	3	-6	1	27	-4	-157	19	-180	53	-193	73	-163	11	-175	22	-173	47	-209
7	12	6	[illegible]	0	3	14	17	-16	10	-15	30	-5	39	5	34	-15	30	-16	35	-28

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
13	-143	-61	[illegible]	-56	-130	-50	-156	-39	-109	-32	-26	21	-103	-1	-82	-25	-10	-30	-25	-51
-7	-306	-103	-241	-48	-274	-80	-293	-85	-258	-63	-44	31	-190	-21	-187	-65	-71	-85	-113	-103
12	-435	-133	-407	-111	-459	-78	-445	-118	-458	-110	-46	48	-282	-23	-279	-96	-151	-132	-190	-136
30	-715	-145	-614	-32	[illegible]	-65	-641	-126	-632	-152	-67	67	-399	-20	-425	-107	-256	-164	-305	-152
39	-545	-105	[illegible]	-76	-459	-52	-505	-86	-500	-104	-50	60	-302	-6	-323	-80	-177	-122	-210	-133
42	-175	-21	[illegible]	-6	-159	4	-177	11	-151	-25	-25	35	-120	15	-110	-4	-35	-24	-61	-48
37	-513	-106	[illegible]	-62	[illegible]	-40	-501	-79	-437	-100	-44	58	-293	-1	-314	-81	-178	-118	-202	-129
53	-715	-128	-611	-74	[illegible]	-44	-676	-100	-633	-146	-61	84	-400	1	-428	-91	-263	-150	-309	-152
53	-528	-111	[illegible]	-65	-474	-40	-516	-70	-510	-105	-43	70	-302	3	-324	-74	-188	-106	-204	-116
52	-174	-33	[illegible]	-16	-157	5	-182	3	-157	-21	-20	36	-114	11	-106	-4	-47	-20	-51	-36
38	-10	13	[illegible]	22	-13	22	-25	26	-74	8	9	25	-16	20	-14	14	-18	10	-21	9

S12	S13	S14	S15	S16
-99	5	-192	16	-52
-193	21	-134	13	-153
-292	36	-294	19	-222
-417	63	-347	[illegible]	-320
-313	47	-304	17	-236
-121	29	-122	[illegible]	-97
-305	47	-309	32	-217
-413	55	-404	3	-243
-314	55	-236	-3	-230
-119	35	-106	[illegible]	-41
-7	5	0	[illegible]	16

TABLE B3 CONTINUED

ELEMENT 32Y UNDER ACTION τ_2

STRESS / MEAN VALUES / INDIVIDUAL VALUES OF STRAIN (microstrain)

τ_2 lb/in	ϵ_x	ϵ_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-139.14	4.4	-119.1	21.4	6	0	-7	10	6	-4	12	7	-20	26	-12	7	0	-3	4	22	12
-279.59	12.4	-251.7	35.8	13	-3	-11	22	14	-1	24	5	-15	40	-7	19	0	-1	7	38	23
-418.80	13.9	-395.8	45.3	6	-11	-26	34	15	3	20	6	-16	50	-9	32	-9	3	4	42	27
-558.33	20.3	-540.7	62.9	7	-12	-30	55	22	18	22	1	-6	59	-5	40	1	11	9	44	37
-419.81	15.2	-398.3	51.0	6	-14	-25	45	21	12	23	6	-13	45	-7	31	-3	2	8	45	30
-139.75	7.0	-120.1	23.2	4	-7	-4	11	12	-7	21	7	-16	26	0	13	-2	0	3	34	10
-418.65	16.1	-393.8	52.6	2	-15	-28	37	19	7	23	0	-12	48	-7	34	0	5	7	47	31
-557.71	21.2	-540.2	60.9	10	-11	-38	59	25	19	31	1	-6	63	-9	50	-6	15	6	52	32
-419.73	19.6	-399.4	56.3	11	-9	-23	43	27	11	31	7	-9	53	-10	43	-1	16	4	52	29
-139.68	14.3	-113.5	30.7	7	4	-9	26	20	1	20	16	-13	36	0	30	0	13	7	42	16
-0.0	9.2	19.6	4.4	5	1	0	9	17	0	7	6	10	19	4	20	9	12	12	8	5

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
0	5	8	-1	5	3	17	-37	-182	-32	-155	-19	-135	-102	-159	7	-290	57	-227	26	-257
13	16	33	5	19	18	22	-70	-381	-71	-333	-53	-294	-173	-331	19	-572	95	-467	52	-497
11	23	39	10	24	30	20	-104	-607	-110	-548	-79	-497	-229	-511	51	-898	148	-763	95	-821
18	34	43	18	29	47	15	-102	-842	-112	-814	-72	-753	-242	-757	182	-1290	284	-1135	217	-1211
5	32	34	10	15	33	16	-53	-662	-48	-614	-18	-568	-149	-560	117	-962	216	-831	159	-900
-2	18	8	1	6	7	19	10	-238	27	-205	40	-184	-32	-200	56	-345	120	-285	91	-314
11	35	42	12	23	33	24	-73	-646	-71	-591	-44	-527	-174	-544	96	-928	194	-799	138	-859
17	29	52	13	35	44	18	-83	-870	-101	-835	-46	-756	-215	-757	206	-1315	311	-1164	237	-1244
15	31	50	13	26	32	23	-39	-669	-36	-627	-7	-571	-148	-567	136	-975	230	-844	166	-910
7	19	21	4	20	11	32	26	-234	32	-199	68	-183	-23	-152	70	-351	132	-283	102	-315
9	16	4	6	10	16	2	22	15	6	-7	17	13	9	7	25	-3	39	-6	27	-9

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-2	-299	53	-345	96	-302	50	-315	-9	-254	47	-179	61	-118	10	-129	-59	-93	-76	-133	-25
12	-605	70	-658	137	-556	69	-623	-16	-535	52	-335	93	-246	18	-254	-71	-159	-110	-240	-14
43	-953	121	-1023	207	-852	108	-944	0	-818	43	-547	139	-415	37	-407	-85	-243	-149	-371	5
173	-1369	237	-1463	332	-1230	209	-1339	93	-1205	89	-780	226	-627	105	-587	-54	-320	-168	-500	60
118	-1027	165	-1033	253	-909	157	-1005	55	-891	82	-571	182	-450	76	-453	-34	-263	-129	-394	37
65	-375	106	-409	142	-357	87	-372	22	-311	78	-230	106	-145	44	-164	-22	-121	-58	-162	0
99	-987	151	-1055	238	-890	138	-975	33	-866	80	-565	162	-430	64	-430	-44	-246	-135	-384	16
207	-1407	265	-1482	368	-1260	235	-1363	115	-1241	99	-783	243	-640	118	-603	-40	-329	-159	-500	74
135	-1038	177	-1102	258	-922	157	-1015	55	-907	89	-577	194	-457	87	-456	-32	-264	-129	-408	37
85	-369	117	-420	156	-365	103	-377	33	-325	86	-221	111	-135	55	-159	-11	-91	-53	-155	9
34	-6	24	-6	26	-24	28	-13	16	4	36	-33	22	13	12	0	37	20	18	14	5

S12	S13	S14	S15	S16
-145	7	-136	-16	-109
-279	1	-294	-23	-232
-447	21	-489	-35	-382
-647	73	-711	-1	-562
-480	49	-525	0	-403
-166	36	-164	10	-140
-455	34	-498	-15	-399
-639	88	-723	8	-576
-478	49	-526	0	-416
-164	37	-164	12	-137
9	14	9	11	-11

TABLE B3 CONTINUED

ELEMENT 33 UNDER ACTION T_z

STRESS T_z lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-129.38	15.1	-170.7	-1.3	6	24	8	13	9	19	9	34	11	26	10	28	19	15	27	31	1
-267.63	27.3	-376.5	-14.8	19	36	21	21	16	37	17	56	13	41	14	41	38	24	48	38	9
-406.96	36.4	-596.9	-30.4	28	49	24	39	27	56	31	67	20	58	9	51	47	38	65	51	6
-546.83	48.7	-811.5	-48.4	41	60	33	48	26	71	36	84	34	79	15	66	64	47	85	51	19
-408.07	39.3	-606.4	-31.0	34	46	24	36	28	53	30	67	29	65	12	60	56	42	70	48	8
-127.72	17.2	-181.8	-0.7	5	20	6	15	20	19	12	32	15	28	10	35	22	16	33	25	0
-407.00	40.0	-597.2	-28.8	27	48	26	35	32	55	33	67	27	62	17	61	55	40	71	43	10
-545.71	50.3	-812.0	-46.5	36	63	32	47	36	68	42	86	36	75	15	69	68	51	91	59	17
-407.26	37.8	-610.7	-27.3	13	44	17	33	24	55	32	68	25	62	15	57	58	38	75	39	7
-128.07	21.9	-181.5	-1.0	15	24	18	25	25	25	18	40	21	28	16	37	30	19	37	38	-2
-2.65	13.1	3.8	0.1	9	3	11	5	31	11	20	14	20	12	5	20	19	10	22	15	10

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
14	11	8	6	0	28	-3	-258	-64	-246	-126	-173	-129	-118	-167	-169	-195	-158	-201	-147	-207
41	17	28	12	13	50	-3	-476	-181	-473	-288	-340	-313	-265	-365	-330	-463	-315	-461	-296	-486
61	18	31	15	13	61	-5	-696	-337	-713	-489	-583	-524	-419	-593	-465	-771	-435	-763	-414	-814
93	32	51	29	23	79	-8	-900	-488	-939	-669	-801	-742	-574	-806	-555	-1115	-514	-1109	-496	-1160
63	28	36	24	13	68	-7	-681	-340	-715	-505	-574	-558	-401	-614	-445	-810	-413	-799	-394	-849
29	10	5	10	7	37	-9	-246	-64	-258	-130	-178	-158	-112	-195	-157	-225	-139	-234	-138	-244
64	32	33	26	17	68	-3	-627	-331	-718	-484	-586	-526	-409	-553	-451	-786	-419	-772	-399	-814
86	35	46	33	23	82	2	-895	-497	-936	-682	-793	-752	-558	-810	-540	-1136	-502	-1119	-470	-1178
65	26	37	25	13	73	-9	-690	-346	-724	-511	-585	-557	-404	-623	-439	-825	-406	-814	-390	-866
28	11	6	12	8	40	-2	-250	-54	-262	-125	-179	-158	-104	-196	-163	-234	-138	-233	-130	-254
11	9	-1	[illegible]	12	10	14	-7	2	-20	3	-2	-3	7	-23	6	-20	16	-8	17	-25

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-153	-191	-143	-157	-113	-172	-168	-219	-135	-166	-47	-51	-62	-72	-116	-92	-52	-130	-136	-20	-128
-287	-449	-319	-367	-223	-399	-320	-491	-261	-387	-123	-140	-127	-212	-215	-240	-99	-255	-242	-44	-248
-392	-742	-456	-601	-320	-651	-453	-720	-377	-648	-193	-245	-166	-378	-316	-393	-156	-394	-361	-89	-341
-462	-1063	-581	-863	-390	-960	-543	-1111	-450	-955	-253	-360	-179	-571	-357	-572	-214	-522	-465	-135	-436
-369	-783	-443	-642	-306	-658	-444	-937	-363	-684	-186	-262	-151	-393	-313	-414	-146	-402	-357	-91	-340
-128	-223	-122	-214	-91	-217	-166	-263	-119	-200	-42	-57	-61	-76	-106	-118	-37	-132	-129	-20	-116
-381	-748	-446	-624	-310	-671	-440	-814	-356	-680	-193	-242	-150	-390	-312	-400	-145	-392	-361	-85	-343
-439	-1075	-555	-971	-372	-954	-523	-1140	-431	-990	-244	-368	-161	-594	-388	-581	-204	-523	-462	-144	-431
-358	-780	-433	-655	-299	-702	-431	-949	-359	-706	-184	-253	-141	-399	-299	-414	-147	-403	-352	-94	-333
-123	-216	-124	-201	-92	-220	-164	-271	-114	-209	-40	-61	-48	-90	-110	-110	-36	-131	-130	-15	-114
16	-14	10	-30	17	-26	16	-31	23	-33	12	1	16	-5	1	-14	17	-4	5	13	1

S12	S13	S14	S15	S16
-112	-57	-111	-29	-21
-229	-115	-253	-74	-90
-366	-146	-412	-111	-172
-498	-171	-572	-141	-265
-387	-132	-431	-104	-176
-147	-35	-137	-12	-29
-372	-140	-416	-109	-170
-508	-156	-576	-133	-266
-391	-125	-446	-103	-178
-143	-29	-141	-12	-29
-79	24	-19	[illegible]	6

TABLE B3 CONTINUED

ELEMENT S2 UNDER ACTION T_1

STRESS T_1 lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-210.44	-86.3	6.8	-49.5	-15	35	-42	-90	-39	-6	22	30	34	-79	137	56	100	36	58	42	36
-433.90	-201.5	20.8	-70.8	7	62	-3	-111	-3	26	56	69	108	-54	251	75	176	-13	116	22	64
-656.93	-334.1	38.2	-91.8	23	87	35	-115	47	75	104	127	174	-52	350	76	237	-76	152	-45	98
-881.06	-476.0	53.7	-115.6	50	104	86	-106	108	122	158	151	224	-42	450	50	289	-148	182	-124	121
-1102.91	-615.9	74.4	-130.6	70	142	134	-83	170	173	216	217	271	-34	536	22	330	-234	207	-208	152
-658.41	-345.4	52.7	-92.7	90	137	40	-91	57	93	117	136	199	-48	437	92	282	-99	129	-66	138
-212.21	-83.0	38.4	-41.1	123	161	23	-53	-20	20	37	32	83	-86	278	81	223	-31	56	55	103
-658.14	-339.2	55.9	-91.3	107	139	72	-84	58	91	111	135	192	-45	419	85	309	-91	135	-47	106
-1103.45	-617.6	83.3	-125.8	121	155	154	-73	198	187	221	231	280	-29	547	26	350	-235	218	-205	138
-659.71	-345.1	60.5	-87.2	116	151	60	-81	69	106	127	139	217	-42	469	91	304	-106	133	-75	141
-212.59	-82.5	45.3	-40.8	140	173	50	-40	-12	27	53	30	91	-83	298	87	252	-29	60	55	105
-1.77	12.6	44.5	0.5	151	112	82	42	19	44	35	22	58	5	149	24	149	-73	37	20	71

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-29	-40	-48	-47	-15	-93	32	-103	-10	-29	-43	-110	-128	-57	-47	-115	-44	-105	-63	-106	-177
-40	-62	-95	-55	0	-143	61	-256	-70	-239	-131	-204	-259	-157	-140	-278	-137	-265	-156	-201	-349
-30	-56	-83	-56	31	-154	115	-451	-171	-397	-234	-305	-382	-304	-251	-482	-244	-436	-262	-303	-511
-17	-53	-59	-40	45	-156	150	-637	-288	-568	-336	-413	-500	-457	-366	-695	-364	-626	-378	-418	-684
16	-41	-13	-14	100	-142	212	-848	-404	-741	-441	-524	-607	-605	-459	-927	-470	-822	-471	-536	-832
-32	-57	-103	1	19	-73	123	-512	-142	-464	-225	-296	-391	-322	-247	-552	-213	-496	-251	-304	-522
-22	-25	-89	35	30	9	44	-163	46	-176	-24	-74	-132	-57	-38	-179	19	-164	-29	-75	-173
-17	-45	-82	-7	35	-50	125	-480	-148	-441	-231	-301	-377	-314	-244	-522	-209	-476	-252	-304	-511
28	-7	-14	15	59	-109	217	-852	-402	-756	-440	-523	-609	-609	-460	-917	-473	-819	-481	-538	-832
-26	-45	-59	16	29	-56	131	-507	-146	-473	-224	-295	-397	-320	-250	-556	-197	-475	-252	-309	-525
-20	-21	-90	-1	27	25	59	-165	45	-191	-30	-77	-130	-58	-46	-175	20	-173	-27	-77	-175
18	41	0	40	63	65	10	-25	40	-54	18	14	17	23	4	-39	59	-18	36	32	9

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-104	-58	-175	-52	-98	-62	-115	-123	-45	-44	81	-68	-6	7	-175	-131	-156	-5	-30	31	110
-201	-165	-395	-132	-210	-159	-227	-252	-119	-123	230	-154	35	10	-420	-241	-333	-46	-102	35	216
-330	-302	-619	-260	-322	-238	-347	-337	-205	-235	256	-253	38	-54	-590	-300	-481	-87	-194	44	239
-462	-465	-853	-379	-433	-424	-476	-538	-293	-395	283	-337	38	-147	-728	-367	-667	-174	-282	52	220
-591	-642	-1076	-469	-543	-582	-601	-664	-364	-541	325	-397	2	-240	-883	-415	-839	-204	-366	84	186
-306	-346	-642	-230	-310	-296	-354	-415	-194	-269	376	-334	131	-33	-696	-298	-499	-86	-256	81	323
-48	-62	-200	-6	-88	-58	-94	-134	-17	-46	410	-192	225	131	-494	-195	-146	28	-122	98	398
-321	-325	-621	-287	-313	-276	-349	-407	-197	-274	354	-315	135	-19	-665	-307	-486	-100	-238	84	307
-593	-645	-1065	-436	-538	-527	-607	-697	-375	-573	362	-418	19	-210	-886	-435	-844	-209	-380	93	210
-302	-352	-641	-225	-303	-232	-356	-414	-176	-299	391	-336	148	-7	-703	-305	-471	-89	-258	97	329
-48	-55	-192	[illegible]	-86	-50	-73	-125	-16	-44	443	-202	239	148	-501	-206	-146	34	-125	107	409
39	23	-23	-41	-1	12	36	14	19	2	431	-110	250	165	-392	-155	14	26	-59	88	424

S12	S13	S14	S15	S16
161	-42	-142	-121	6
219	-170	-301	-276	41
194	-299	-425	-324	56
160	-402	-543	-377	3
124	-494	-672	-460	-54
227	-359	-461	-342	76
309	-139	-259	-241	149
232	-303	-463	-363	40
130	-471	-702	-456	-48
248	-340	-493	-345	90
326	-126	-292	-234	169
274	-116	-212	-244	147

TABLE B3 CONTINUED

ELEMENT 53 UNDER ACTION T.

STRESS T. lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-211.28	-166.5	10.2	-63.3	19	0	0	-25	-24	-29	-21	7	69	97	22	72	36	39	69	38	-40
-434.78	-372.9	20.6	-91.4	6	1	8	-9	-50	-18	-27	58	146	129	32	84	64	78	136	99	-63
-656.67	-543.5	34.9	-125.0	-10	11	35	41	-60	4	-14	113	210	141	47	78	97	100	189	141	-74
-879.71	-760.4	51.1	-151.8	-26	39	63	73	-61	32	-2	180	266	158	48	89	119	125	246	158	-77
-1102.91	-987.5	70.1	-179.1	-33	48	120	137	-43	71	23	241	327	162	52	90	141	137	282	161	-68
-659.21	-569.5	41.1	-120.8	16	-1	89	52	-20	7	-19	150	234	214	61	86	125	74	216	98	-70
-213.51	-232.5	20.3	-61.7	55	-21	40	-8	6	-25	10	83	107	172	72	43	90	14	80	37	-35
-657.44	-601.2	43.7	-131.8	2	16	67	59	-15	20	9	140	224	185	78	73	136	80	198	122	-68
-1103.03	-985.0	75.5	-177.5	-40	50	136	149	-36	94	36	260	338	187	57	90	146	131	285	172	-58
-659.63	570.6	45.4	-118.5	16	0	105	50	-1	17	-12	163	236	235	69	86	127	73	221	102	-73
-212.97	190.2	24.7	-62.8	56	-17	44	1	10	-8	17	95	113	185	79	41	91	8	87	35	-27
-1.00	-8.3	24.9	-12.6	47	-8	59	27	58	16	56	82	56	77	64	-20	44	-36	27	-5	-3

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-25	-18	-44	-41	-20	-30	37	-233	-129	-201	-153	-157	-116	-245	-87	-211	-96	-190	-186	-148	-134
-64	-1	-83	-23	-16	-32	59	-515	-336	-441	-322	-356	-244	-563	-220	-482	-221	-426	-383	-338	-316
-59	34	-119	1	0	-27	79	-790	-558	-704	-471	-597	-377	-903	-364	218	-364	-681	-561	-552	-494
-38	71	-131	28	24	-22	103	-1066	-778	-987	-593	-865	-472	-1289	-452	-102	-480	-965	-712	-802	-643
-15	119	-155	76	34	15	127	-1440	-942	-1340	-693	-1204	-524	-1757	-561	-510	-552	-1342	-799	-1127	-730
-71	7	-128	0	-24	4	50	-429	-562	-815	-403	-689	-286	-1064	-296	47	-286	-797	-490	-649	-425
-59	-23	-77	-12	-41	-8	5	-377	-1130	-286	-130	-211	-57	-368	-49	-338	-42	-254	-174	-184	-115
-52	31	-149	16	0	-12	71	-963	-1555	-756	-440	-640	-326	-981	-340	146	-317	-726	-520	-598	-461
-7	131	-172	96	35	13	125	-1447	-359	-1354	-676	-1216	-515	-1769	-558	-513	-539	-1347	-778	-1136	-713
-65	24	-138	7	-18	-1	62	-339	-571	-826	-395	-703	-277	-1087	-292	34	-277	-807	-484	-665	-426
-51	-17	-98	-4	-33	5	18	-386	-137	-236	-123	-212	-54	-375	-47	-343	-34	-262	-170	-188	-109
11	11	-9	39	6	49	-3	-82	-7	-50	16	-24	28	-56	10	-63	42	-36	19	-25	17

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-217	-159	-189	-135	-147	-147	-118	-102	-202	-284	-133	-103	-85	-11	-147	-22	-121	-323	-76	37	-94
-472	-344	-409	-347	-308	-358	-299	-275	-425	-560	-263	-240	-167	-30	-330	-42	-255	-529	-170	65	-221
-740	-509	-606	-565	-497	-509	-515	-460	-641	-809	-360	-374	-282	-84	-536	-106	-383	-721	-295	70	-332
-1051	-664	-810	-792	-662	-695	-755	-629	-965	-1059	-445	-454	-445	-135	-755	-153	-516	-890	-430	93	-453
-1454	-747	-1028	-979	-866	-839	-1031	-792	-1113	-1297	-523	-516	-646	-163	-1017	-185	-665	-1041	-613	136	-610
-885	-426	-610	-548	-518	-502	-580	-448	-687	-808	-325	-316	-398	26	-620	-95	-463	-688	-308	124	-380
-314	-123	-191	-120	-170	-154	-144	-102	-245	-292	-89	-91	-144	105	-208	3	-212	-333	-39	110	-127
-991	-466	-603	-535	-506	-433	-540	-454	-661	-803	-322	-339	-335	-35	-577	-92	-442	-706	-284	111	-350
-1457	-728	-1024	-956	-365	-853	-1031	-740	-1114	-1281	-509	-510	-651	-144	-1023	-159	-682	-1041	-606	158	-626
-901	-416	-610	-535	-521	-491	-582	-437	-685	-796	-329	-312	-397	33	-622	-81	-485	-692	-313	135	-395
-313	-107	-195	-113	-169	-148	-141	-101	-235	-296	-85	-84	-141	123	-219	4	-229	-324	-33	122	-139
-43	27	5	15	0	20	3	7	-10	-14	68	24	-27	82	-29	11	-95	-47	79	84	4

S12	S13	S14	S15	S16
-14	-104	-41	-85	-44
-92	-222	-126	-205	-145
-177	-368	-200	-292	-256
-238	-539	-258	-361	-404
-251	-725	-298	-419	-367
-109	-395	-169	-327	-349
-2	-49	-64	-212	-75
-152	-340	-181	-336	-269
-250	-718	-290	-417	-571
-109	-391	-167	-350	-368
1	-46	-81	-210	-70
-1	40	-4	-60	0

TABLE B3 CONTINUED

ELEMENT 11 UNDER ACTION T

STRESS T, N/m	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-212.55	-118.9	20.3	-67.1	-2	56	-24	11	-18	-13	-4	31	0	75	-11	32	1	51	0	47	-13
-434.82	-256.7	35.1	-9.2	-10	86	-29	46	-10	-23	-1	61	-4	122	-37	26	4	80	28	71	-2
-660.17	-396.8	53.1	-35.0	-3	120	-25	96	5	-20	-1	92	-6	166	-67	13	2	98	58	87	-8
-882.14	-550.4	69.2	-73.1	5	149	3	150	31	-10	-1	128	-6	211	-104	5	-6	113	94	96	-10
-1106.02	-705.0	89.9	-111.4	17	170	25	199	38	1	-10	164	-10	247	-141	-10	-11	109	132	103	-19
-661.67	-413.5	64.8	-11.5	12	118	13	129	25	4	-31	113	18	213	-57	11	11	83	124	87	1
-214.78	-127.3	39.3	66.2	23	37	12	54	15	10	-49	73	43	139	16	31	25	43	105	53	26
-659.94	-401.6	66.4	-31.5	22	105	14	123	27	2	-9	111	16	215	-51	23	10	89	125	94	5
-1107.41	-702.1	95.7	-121.2	28	167	34	211	55	8	12	168	1	259	-123	-6	-7	120	153	119	0
-662.36	-413.1	68.3	-18.0	27	107	19	141	34	5	-9	121	32	227	-42	11	22	89	144	102	13
-215.85	-129.8	41.1	70.9	41	30	25	54	24	19	-49	83	43	147	23	33	32	45	115	66	32
-2.00	1.3	33.0	123.5	37	-41	49	37	49	34	-26	74	58	68	56	12	31	-2	116	6	61

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
16	-22	27	-7	19	-8	7	-65	-33	-116	-74	-70	-44	-37	-115	-79	-30	-100	-71	-79	-44
-9	-22	45	0	37	-20	14	-151	-55	-220	-155	-149	-102	-139	-262	-168	-83	-198	-158	-153	-114
-18	-21	62	23	54	-24	13	-250	-108	-318	-221	-235	-171	-280	-418	-275	-132	-295	-230	-241	-196
-12	-25	90	52	69	-26	19	-361	-172	-415	-296	-329	-251	-410	-580	-387	-209	-390	-295	-326	-271
-6	-17	116	103	86	-13	25	-430	-250	-508	-355	-432	-331	-555	-741	-505	-294	-478	-368	-421	-354
-5	-10	68	79	42	-34	-2	-285	-106	-324	-223	-257	-167	-322	-429	-282	-105	-317	-220	-252	-196
14	-10	20	33	22	-34	0	-41	-1	-123	-70	-83	-37	-66	-106	-80	6	-123	-62	-95	-45
-8	-23	70	69	35	-30	2	-275	-101	-321	-216	-254	-163	-290	-415	-284	-114	-311	-221	-253	-189
-16	-12	117	113	102	-17	21	-485	-236	-501	-343	-435	-330	-552	-733	-502	-273	-481	-356	-407	-352
-8	-4	62	86	50	-34	-1	-284	-99	-328	-218	-259	-163	-318	-420	-286	-112	-319	-226	-252	-198
11	-3	15	42	17	-31	2	-88	1	-118	-77	-84	-36	-72	-107	-80	11	-119	-60	-95	-47
30	20	0	50	24	-16	28	-3	33	-5	0	-1	6	-17	20	1	26	-15	23	-12	16

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-57	-55	-84	-46	-110	-70	-58	-40	-60	-47	24	-4	-38	-96	-13	-25	7	-56	-44	-31	-80
-131	-160	-177	-104	-209	-148	-126	-98	-156	-151	145	17	-92	-99	-63	-38	-27	-152	-79	-74	-133
-215	-286	-266	-174	-314	-231	-197	-164	-245	-253	220	17	-148	-104	-87	-50	-65	-243	-123	-128	-200
-308	-413	-360	-254	-398	-312	-263	-239	-329	-377	267	-1	-205	-109	-107	-89	-104	-339	-178	-162	-276
-399	-542	-455	-352	-480	-381	-312	-331	-410	-514	306	-24	-260	-149	-128	-146	-136	-460	-222	-189	-351
-228	-255	-265	-172	-330	-233	-189	-173	-244	-257	351	20	-150	-135	-11	-20	-110	-234	-107	-123	-266
-65	-66	-80	-26	-140	-67	-65	-37	-74	-44	377	42	-67	-128	91	64	-74	-6	6	-43	-167
-224	-293	-255	-175	-318	-226	-185	-172	-241	-262	357	17	-165	-136	-18	-26	-105	-228	-98	-120	-257
-395	-541	-442	-342	-479	-385	-300	-335	-401	-515	352	-25	-251	-165	-100	-145	-122	-441	-219	-193	-371
-226	-284	-263	-186	-330	-227	-186	-171	-240	-265	382	15	-153	-139	2	-15	-99	-218	-102	-112	-289
-63	-61	-86	-12	-135	-63	-58	-25	-72	-45	401	58	-68	-135	101	63	-74	5	8	-40	-164
-1	9	-9	19	-24	7	2	8	-3	3	372	60	-21	-70	111	70	-83	69	61	-11	-83

S12	S13	S14	S15	S16
-4	-75	100	-31	23
-34	-138	30	-270	15
-74	-210	-65	-402	2
-90	-299	-145	-543	-7
-107	-381	-239	-696	-17
-48	-210	-107	-553	32
-1	-37	40	-394	47
-56	-208	-93	-504	32
-109	-375	-244	-704	1
-46	-210	-112	-547	40
0	-46	22	-393	53
10	21	-38	-300	34

TABLE B3 CONTINUED

ELEMENT 12 UNDER ACTION T.

STRESS T, lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-213.02	-118.9	20.3	-67.1	51	5	2	-38	10	13	-3	-18	-21	13	11	16	23	53	85	74	0
-438.18	-256.7	35.1	-9.2	83	53	7	-47	12	63	27	2	-5	11	25	27	42	65	146	105	31
-657.56	-396.8	53.1	-35.0	100	115	10	-23	25	98	82	36	-19	15	45	48	50	76	157	134	60
-882.06	-550.4	69.2	-73.1	119	172	19	-8	39	130	137	63	-40	2	54	59	57	78	176	146	96
-1106.60	-705.0	89.9	-111.4	138	237	42	4	73	167	204	96	-50	-4	74	78	57	88	198	151	128
-660.83	-413.5	64.8	-11.5	97	140	-3	-21	42	111	134	49	-6	20	61	52	66	85	214	116	84
-213.82	-127.3	39.2	66.2	55	21	-38	-34	23	43	75	20	71	28	55	11	73	60	177	55	16
-658.10	-401.6	66.4	-31.5	97	125	0	-22	60	100	137	46	21	24	59	54	84	77	214	123	72
-1104.64	-702.1	95.7	-121.2	130	236	46	10	88	162	222	104	-27	3	70	86	66	90	232	147	148
-660.83	-413.1	68.3	-18.0	95	138	0	-19	53	109	138	48	10	16	72	49	81	83	234	107	91
-214.17	-129.8	41.1	70.9	49	30	-31	-31	41	43	75	26	79	32	52	11	85	55	181	51	26
-1.65	1.3	33.0	123.5	17	8	-22	11	31	42	58	29	124	32	33	C	58	1	99	-5	37

INDIVIDUAL VALUES OF STRAIN (microstrain)

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
61	62	64	6	25	-20	25	-105	8	-260	-166	-103	-67	-119	-144	-114	-20	-173	-162	-113	-103
118	83	106	18	13	-41	14	-274	-4	-532	-284	-222	-143	-305	-295	-291	-60	-392	-245	-236	-186
176	103	144	37	43	-15	24	-458	-48	-763	-377	-365	-222	-470	-418	-489	-108	-579	-344	-405	-295
228	131	166	38	53	24	22	-609	-34	-1001	-436	-570	-296	-677	-563	-721	-148	-797	-412	-614	-383
288	176	198	163	55	79	29	-921	-123	-1278	-466	-787	-345	-924	-669	-991	-160	-1049	-443	-854	-431
208	128	163	112	24	-6	19	-551	39	-879	-299	-444	-155	-587	-407	-591	-23	-694	-267	-489	-207
130	86	128	52	7	-39	11	-213	102	-415	-90	-144	8	-247	-109	-218	74	-303	-67	-150	-5
197	140	160	91	50	1	24	-518	0	-819	-319	-428	-168	-542	-398	-548	-42	-666	-292	-463	-230
293	199	196	185	50	77	28	-927	-114	-1295	-451	-794	-326	-939	-648	-1000	-142	-1094	-417	-859	-407
212	143	174	129	19	-3	16	-561	35	-885	-288	-455	-154	-603	-397	-584	-5	-710	-250	-495	-194
128	91	135	59	0	-59	-1	-220	104	-426	-89	-148	6	-254	-109	-223	89	-318	-55	-149	-7
76	76	72	63	13	12	27	-70	72	-112	52	-9	59	-86	36	-85	85	-85	65	-17	73

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-123	-125	-169	-48	-166	-129	-104	-48	-165	-128	78	243	-281	-279	-58	-102	-83	-100	-18	-67	-58
-333	-267	-356	-145	-358	-250	-272	-122	-355	-271	478	338	-469	-480	-43	-278	-143	-293	-81	-37	-330
-545	-401	-555	-246	-539	-336	-370	-196	-568	-414	496	343	-608	-533	-122	-380	-272	-407	-96	-51	-464
-811	-528	-772	-363	-739	-447	-542	-283	-791	-543	450	338	-738	-550	-221	-482	-433	-536	-114	-50	-612
-1110	-615	-1018	-469	-944	-528	-723	-349	-1051	-663	369	357	-891	-597	-343	-543	-620	-642	-114	-36	-773
-708	-341	-594	-216	-599	-314	-409	-171	-629	-379	572	412	-739	-487	-60	-322	-380	-409	-58	-15	-652
-284	-66	-190	6	-239	-32	-115	1	-212	-79	695	373	-622	-327	203	-90	-104	-168	4	52	-468
-624	-351	-572	-209	-577	-319	-400	-172	-589	-380	606	372	-791	-498	-65	-327	-327	-399	-50	-13	-581
-1125	-593	-1013	-452	-952	-525	-728	-341	-1042	-656	446	347	-1002	-587	-290	-530	-637	-644	-82	-25	-798
-716	-325	-597	-218	-613	-319	-405	-164	-624	-381	613	408	-919	-477	-22	-311	-395	-401	-39	-6	-664
-293	-60	-198	2	-252	-34	-118	2	-217	-85	737	356	-660	-319	232	-84	-117	-169	14	42	-477
-103	60	-14	59	-34	49	-4	-8	-41	33	799	160	-508	-157	349	-7	-14	-66	50	123	-415

S12	S13	S14	S15	S16
14	98	261	-133	-165
96	104	395	-698	-239
100	53	408	-861	-266
106	-43	407	-996	-310
130	-174	409	-1106	-351
136	136	436	-990	-280
119	431	438	-874	-211
105	237	443	-1021	-269
140	-28	423	-1210	-350
145	230	448	-1050	-293
117	490	435	-926	-226
101	523	189	-938	-90

TABLE B3 CONTINUED

ELEMENT 13' UNDER ACTION T_1

STRESS T_1 lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-212.13	-162.8	12.8	-28.8	35	0	-30	-4	-17	33	42	10	17	-19	61	-32	40	-25	72	58	66
-438.09	-348.1	28.6	-33.7	68	35	-40	29	-9	69	85	44	49	7	112	-44	62	-35	135	95	95
-658.06	-545.0	47.2	-71.6	147	87	-12	77	17	73	98	85	71	15	134	-51	48	-24	151	136	108
-882.37	-760.5	69.4	-119.7	263	137	50	126	37	108	89	156	103	24	138	-57	33	-23	155	156	111
-663.17	-567.3	62.3	-84.1	233	120	12	119	31	106	91	126	120	0	166	-90	42	-42	153	151	112
-214.24	-171.1	39.0	-34.6	97	82	5	46	10	67	59	72	92	-43	122	-94	63	-55	151	68	116
-659.64	-553.3	61.7	-100.7	178	120	23	98	18	102	77	137	126	11	131	-49	47	-39	165	137	119
-883.29	-761.2	79.7	-130.5	264	168	54	158	34	133	83	185	133	35	139	-50	23	-28	155	168	124
-662.94	-568.5	64.7	-96.6	212	131	25	128	23	125	86	145	137	-3	159	-83	32	-43	154	145	122
-214.01	-172.1	39.6	-41.7	96	84	7	54	15	62	69	64	96	-41	132	-110	67	-74	168	65	118
-0.88	2.5	34.2	-14.5	36	90	16	77	10	65	38	55	63	-4	52	-57	22	-52	94	-4	85

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-6	39	-32	6	-30	-36	23	-209	-24	-243	-77	-218	-196	-124	-115	-264	-78	-198	-52	-198	-167
-33	96	-65	48	-29	-59	56	-446	-98	-520	-172	-465	-322	-219	-267	-576	-176	-453	-118	-459	-313
-46	130	-66	107	7	-61	112	-732	-199	-818	-260	-720	-437	-579	-407	-936	-259	-733	-195	-716	-436
-23	209	-63	168	32	-42	163	-1076	-269	-1197	-323	-1021	-502	-924	-527	-1397	-305	-1102	-213	-1046	-503
-32	196	-77	200	-2	-40	116	-976	-109	-956	-157	-828	-337	-726	-352	-1132	-134	-897	-52	-852	-321
-2	110	-58	191	-43	0	25	-358	58	-377	70	-336	-95	-237	-47	-431	28	-340	100	-337	-80
-24	171	-66	202	2	0	107	-846	-157	-903	-180	-784	-360	-673	-352	-1059	-195	-841	-98	-821	-347
-15	233	-71	229	37	-9	173	-1132	-255	-1237	-283	-1044	-465	-963	-468	-1455	-276	-1152	-162	-1109	-455
-25	204	-86	214	0	-24	107	-873	-130	-952	-165	-815	-340	-717	-350	-1129	-170	-894	-60	-863	-326
-1	115	-62	212	-46	15	-2	-363	63	-390	63	-338	-92	-243	-44	-436	33	-353	107	-343	-64
10	92	-14	214	3	50	-6	-89	67	-84	116	-76	51	-48	58	-116	82	-102	149	-100	80

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-194	-180	-272	-148	-178	-45	-165	-102	-243	-209	25	45	-103	99	-221	-149	-144	-299	11	86	76
-432	-389	-539	-289	-407	-111	-391	-226	-467	-386	85	46	-277	187	-425	-317	-274	-473	33	83	44
-730	-570	-798	-427	-655	-214	-622	-362	-720	-543	31	28	-502	177	-611	-447	-417	-601	19	31	-66
-1124	-720	-1091	-554	-948	-330	-693	-473	-1016	-688	-77	60	-793	161	-812	-553	-615	-688	-12	-41	-237
-914	-473	-835	-420	-732	-198	-709	-336	-762	-497	59	134	-635	247	-742	-407	-470	-594	60	57	-149
-315	-99	-289	-100	-243	13	-245	-73	-249	-121	272	176	-282	315	-469	-121	-191	-360	123	267	140
-823	-495	-812	-383	-695	-190	-677	-339	-740	-504	69	76	-630	247	-716	-405	-470	-617	42	97	-71
-1163	-662	-1096	-510	-774	-324	-918	-463	-1008	-657	-37	89	-851	200	-876	-526	-618	-694	-10	3	-216
-901	-483	-840	-371	-738	-170	-718	-338	-759	-490	66	132	-634	254	-761	-399	-479	-615	53	70	-103
-314	-97	-297	-99	-249	20	-248	-74	-247	-132	274	208	-312	321	-488	-113	-199	-367	142	272	159
-63	67	-7	41	-31	56	-37	21	-14	39	360	193	-169	263	-377	67	-55	-191	142	276	254

S12	S13	S14	S15	S16
16	-90	-194	-315	-77
13	-197	-360	-644	-123
-2	-354	-419	-905	-157
28	-549	-428	-924	-197
91	-398	-395	-815	-174
75	59	-322	-595	-105
51	-297	-411	-850	-175
49	-521	-421	-957	-198
85	-353	-390	-841	-178
49	92	-324	-586	-124
8	252	-211	-413	-66

TABLE B3 CONTINUED

ELEMENT 21(UNDER ACTION T_r

STRESS T, lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-210.67	-80.0	10.9	9.2	22	7	6	-7	11	16	31	6	-7	58	7	39	-10	16	-3	29	0
-433.63	-169.3	21.1	9.1	56	20	25	-6	32	39	55	46	-5	91	17	46	-21	31	4	66	-7
-656.40	-261.8	30.4	0.5	68	43	42	4	52	74	73	49	4	109	26	37	-37	35	0	94	-23
-880.27	-358.8	38.8	-3.1	90	47	59	20	59	97	98	74	19	128	37	38	-62	33	-4	113	-34
-1102.10	-455.0	48.3	-1.3	96	64	78	22	83	117	124	84	31	153	45	39	-83	33	-13	132	-39
-657.79	-270.9	33.2	-30.1	91	46	42	1	30	94	49	86	37	125	36	44	-73	42	-5	109	-35
-212.24	-86.9	20.9	-50.1	91	13	17	-1	-8	51	-10	62	31	73	24	38	-57	43	12	55	-17
-657.56	-264.7	33.8	-27.0	95	46	40	13	35	88	53	62	29	121	30	46	-67	43	1	103	-34
-1104.45	-456.0	51.2	-4.0	119	72	84	18	61	126	114	109	57	166	47	31	-96	31	-26	142	-35
-657.94	-273.3	33.8	-31.5	112	50	53	-1	23	98	42	93	55	127	31	36	-83	45	-18	106	-29
-212.05	-86.3	21.9	-52.7	107	15	13	-3	0	58	-12	75	43	73	20	43	-69	40	6	51	-18
-1.31	-3.0	18.5	-58.2	90	16	4	15	-9	45	-27	64	58	3	18	12	-60	23	12	16	0

The table header also reads "INDIVIDUAL VALUES OF STRAIN (microstrain)" over columns X1–X17.

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-45	8	-11	5	-6	18	16	-73	-66	-92	-103	-79	-73	-62	-53	-81	-79	-50	-97	-54	-94
-68	23	3	10	-1	27	39	-174	-124	-176	-194	-157	-144	-139	-132	-181	-182	-102	-175	-112	-197
-79	55	25	30	10	53	70	-286	-219	-251	-291	-235	-233	-231	-217	-291	-267	-156	-260	-170	-277
-82	83	56	42	28	45	95	-405	-302	-330	-380	-313	-322	-342	-316	-404	-363	-217	-348	-227	-373
-86	117	87	58	39	63	129	-521	-387	-402	-461	-388	-413	-459	-419	-512	-442	-273	-434	-289	-464
-93	66	38	57	10	37	66	-317	-213	-236	-299	-231	-223	-274	-238	-305	-254	-152	-250	-156	-274
-55	28	11	64	8	23	22	-102	-57	-74	-109	-80	-60	-100	-55	-105	-62	-37	-79	-44	-76
-83	68	36	57	19	41	74	-308	-215	-234	-289	-229	-223	-268	-224	-306	-251	-156	-251	-165	-272
-86	121	90	75	48	69	126	-538	-386	-379	-457	-376	-396	-479	-435	-515	-426	-256	-425	-268	-455
-102	76	41	65	24	25	60	-330	-221	-218	-293	-223	-221	-290	-255	-314	-241	-148	-247	-154	-270
-63	38	8	70	11	21	20	-112	-65	-62	-104	-76	-57	-111	-59	-110	-50	-32	-70	-38	-71
-15	41	5	85	13	19	16	-26	-17	23	-3	5	15	-40	6	-22	22	18	10	10	8

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-68	-109	-73	-118	-66	-64	-54	-68	-92	-140	-2	4	-63	9	-64	-26	-42	-94	0	-12	-35
-157	-225	-163	-252	-155	-144	-105	-162	-202	-300	-6	-1	-97	-3	-123	-85	-116	-208	9	-10	-71
-254	-335	-252	-366	-266	-210	-165	-262	-320	-460	-22	3	-144	-31	-203	-131	-194	-314	9	-19	-102
-359	-465	-347	-488	-390	-252	-214	-358	-430	-625	-37	-3	-193	-62	-285	-183	-263	-418	-3	-41	-134
-470	-583	-447	-610	-517	-357	-275	-453	-538	-749	-53	-13	-235	-87	-374	-232	-319	-515	-26	-63	-162
-283	-354	-270	-386	-313	-136	-172	-254	-350	-430	-15	-9	-156	-28	-258	-135	-269	-329	65	-5	-105
-100	-119	-102	-139	-109	-47	-72	-48	-138	-161	36	21	-89	20	-135	-53	-194	-130	159	47	-44
-274	-338	-270	-355	-392	-186	-134	-245	-335	-459	-9	7	-160	-19	-249	-130	-253	-322	75	5	-113
-468	-606	-453	-627	-528	-351	-274	-452	-547	-817	-67	-35	-245	-87	-385	-219	-334	-501	-21	-82	-170
-298	-367	-278	-334	-329	-146	-178	-248	-353	-498	-25	-13	-172	-22	-264	-134	-279	-309	73	-16	-117
-105	-123	-106	-125	-114	-49	-69	-42	-143	-167	36	19	-95	33	-140	-46	-207	-118	188	47	-57
-27	2	-31	-13	-2	29	-7	31	-38	-23	62	22	-37	36	-95	0	-174	-31	219	63	-3

S12	S13	S14	S15	S16
-44	-20	-47	-37	-93
-108	-55	-101	-141	-172
-164	-104	-145	-255	-222
-228	-170	-206	-332	-269
-296	-236	-263	-415	-317
-162	-118	-146	-252	-208
-35	-2	-37	-49	-103
-153	-107	-123	-261	-212
-325	-232	-266	-406	-298
-181	-116	-137	-251	-138
-43	-2	-25	-39	-34
2	40	0	-23	-27

TABLE B3 CONTINUED

ELEMENT 22X UNDER ACTION T_1

STRESS T_1 lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-210.24	-117.8	16.5	-8.5	29	19	0	-5	-7	0	-2	32	101	29	60	16	47	11	-2	4	-4
-358.35	-263.1	24.9	-7.8	35	29	6	-20	-17	-13	-4	78	159	28	96	15	97	23	24	7	-26
-655.48	-412.8	35.2	-17.2	47	41	33	-38	-15	-24	-3	120	205	40	132	10	142	33	55	-9	-23
-880.41	-566.1	49.7	-25.4	61	57	67	-49	8	-33	5	172	244	61	171	10	181	42	89	-19	-13
-1113.07	-729.3	62.6	-33.0	70	81	102	-44	17	-44	15	221	277	56	207	12	219	44	121	-46	2
-660.67	-430.4	42.0	-2.7	55	53	65	-40	16	-28	-23	123	246	48	166	-6	161	40	92	-21	-6
-214.47	-134.8	24.6	21.1	53	44	26	-17	15	-9	-26	37	164	12	103	-21	80	23	53	18	-4
-658.37	-419.1	45.5	-12.7	74	63	57	-23	16	-28	0	123	237	40	160	-2	163	32	94	1	-3
-1108.80	-725.0	68.0	-35.7	89	77	111	-37	29	-39	15	222	291	66	214	19	232	62	131	-38	5
-660.63	-428.4	44.4	7.7	68	52	67	-49	14	-23	-21	128	254	53	173	-11	172	50	104	-17	-6
-212.85	-133.5	23.6	21.7	63	45	24	-30	20	-7	-27	29	167	6	107	-18	89	33	59	15	-2
-0.69	0	16.6	18.1	53	39	34	-7	42	-9	-6	10	51	4	42	-20	34	15	42	8	28

INDIVIDUAL VALUES OF STRAIN (microstrain)

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
5	14	-7	20	15	-1	10	-87	-82	-159	-117	-92	-81	-110	-108	-147	-91	-127	-111	-118	-101
-4	46	-16	19	35	-10	60	-216	-178	-332	-262	-225	-203	-263	-271	-335	-189	-277	-236	-258	-216
-4	78	-23	35	52	-15	97	-373	-290	-488	-410	-364	-336	-414	-430	-514	-295	-425	-364	-390	-346
6	110	-11	53	70	-12	151	-540	-416	-646	-563	-503	-472	-579	-608	-700	-398	-558	-486	-514	-476
25	145	-4	74	90	-15	193	-729	-559	-796	-697	-647	-618	-751	-787	-910	-517	-707	-620	-649	-609
-31	99	-30	64	46	-13	104	-388	-298	-436	-413	-370	-352	-442	-459	-553	-276	-438	-349	-397	-344
-18	30	-5	36	19	-7	26	-83	-59	-171	-111	-117	-88	-141	-141	-201	-50	-161	-92	-140	-100
-6	90	-11	50	65	-6	102	-399	-294	-490	-407	-368	-350	-425	-438	-540	-280	-429	-352	-389	-337
16	154	-1	89	109	-13	196	-726	-556	-802	-706	-647	-605	-750	-775	-906	-502	-703	-603	-644	-590
-31	98	-23	53	51	-12	101	-386	-296	-493	-405	-372	-345	-444	-458	-551	-276	-432	-350	-394	-340
-27	29	-7	26	11	-17	21	-86	-60	-180	-106	-106	-88	-135	-132	-206	-53	-164	-89	-138	-92
-28	17	-1	13	14	-4	7	12	35	-11	29	9	7	-7	0	-26	35	-10	19	-5	19

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-108	-104	-140	-144	-122	-102	-155	-160	-113	-136	-50	-109	-28	-92	-20	-103	-20	-36	-89	-61	-91
-258	-276	-316	-300	-265	-212	-320	-339	-273	-284	-119	-200	-47	-105	-88	-233	-114	-103	-146	-123	-157
-410	-447	-492	-474	-406	-332	-477	-528	-443	-451	-221	-322	-63	-92	-145	-373	-232	-169	-203	-169	-230
-563	-635	-664	-635	-556	-463	-629	-712	-621	-638	-347	-428	-77	-67	-218	-509	-375	-230	-245	-234	-289
-733	-845	-844	-834	-719	-597	-774	-917	-808	-939	-499	-558	-90	-25	-279	-658	-517	-315	-284	-321	-362
-437	-477	-525	-471	-452	-345	-513	-571	-499	-463	-252	-350	-12	-18	-160	-393	-306	-134	-225	-190	-181
-146	-125	-203	-130	-168	-37	-209	-197	-178	-116	-42	-76	37	-50	-44	-115	-63	9	-128	-49	-1
-429	-453	-508	-462	-429	-325	-481	-546	-480	-450	-249	-305	-34	-65	-154	-375	-258	-151	-206	-162	-178
-728	-836	-837	-825	-724	-574	-789	-912	-809	-840	-506	-544	-87	-26	-262	-644	-529	-308	-298	-313	-339
-435	-472	-516	-469	-451	-345	-505	-575	-500	-462	-251	-350	-11	-11	-138	-375	-305	-129	-223	-188	-179
-149	-125	-203	-127	-173	-36	-209	-146	-177	-111	-36	-91	44	-43	-19	-112	-79	-5	-136	-50	-1
-24	-15	-32	23	-18	25	-31	-15	-47	29	29	29	42	38	14	0	-31	28	-28	31	83

S12	S13	S14	S15	S16
-12	-43	8	-73	6
-60	-109	-98	-231	11
-117	-176	-217	-357	22
-179	-251	-365	-477	21
-274	-333	-509	-560	15
-164	-182	-290	-392	58
-59	-19	-41	-216	45
-142	-163	-246	-388	30
-262	-323	-458	-573	16
-165	-171	-298	-405	39
-51	-22	-32	-214	37
0	31	-11	-93	44

TABLE B3 CONTINUED

ELEMENT 23 UNDER ACTION T_1

STRESS T, lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-211.55	-192.2	28.2	-26.7	51	20	44	34	23	101	34	-5	85	31	114	-17	135	3	11	47	34
-432.83	-395.4	51.4	-24.3	71	74	90	77	87	158	79	41	146	19	180	-48	219	10	30	89	57
-657.48	-609.7	71.6	-6.0	84	117	154	120	147	210	120	90	204	-2	240	-83	290	2	49	107	63
-880.64	-822.4	95.2	3.9	113	169	221	161	217	255	157	135	253	-12	293	-100	349	2	75	129	74
-1103.41	-1041.0	117.9	18.8	151	223	290	192	277	313	179	202	296	-38	345	-116	394	7	106	149	85
-656.55	-627.7	83.3	27.9	141	130	208	107	238	209	162	137	235	-27	256	-85	312	4	66	125	57
-215.12	-221.1	44.5	50.6	101	64	92	30	147	91	90	58	125	5	128	-23	171	7	-2	89	33
-657.44	-617.8	83.3	34.1	123	134	195	128	203	224	138	108	227	-10	247	-69	291	14	59	138	70
-1102.76	-1036.8	127.4	36.1	154	245	309	209	291	327	198	211	319	-42	345	-109	388	16	114	175	104
-660.40	-637.3	87.7	47.4	140	140	214	123	246	218	168	135	244	-26	260	-79	296	16	73	139	65
-212.74	-220.6	48.7	59.5	104	68	100	40	150	99	101	75	132	3	134	-18	162	18	5	94	41
-1.23	-16.3	32.4	79.8	95	62	73	16	107	16	49	88	73	-40	33	6	23	14	-28	63	26

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-57	32	3	15	-21	95	-69	-159	-91	-198	-213	-237	-185	-106	-95	-189	-103	-215	-192	-266	-317
-77	66	4	8	-13	199	-98	-343	-173	-403	-420	-497	-367	-275	-238	-426	-204	-432	-379	-538	-590
-63	85	32	4	-20	277	-129	-585	-282	-616	-598	-770	-537	-480	-409	-682	-342	-667	-553	-807	-859
-29	112	87	7	-26	354	-158	-838	-418	-839	-771	-1056	-685	-699	-577	-939	-488	-917	-722	-1080	-1107
-2	137	118	39	-39	420	-179	-1111	-554	-1068	-915	-1361	-832	-933	-742	-1216	-636	-1187	-870	-1370	-1317
-45	98	66	-17	-39	299	-163	-661	-242	-625	-577	-855	-506	-499	-394	-681	-300	-712	-555	-886	-909
-3	12	24	-64	10	166	-96	-257	5	-225	-202	-352	-166	-124	-63	-237	-34	-250	-210	-382	-416
-24	70	61	-4	-15	301	-141	-651	-252	-626	-574	-839	-492	-511	-387	-704	-314	-698	-538	-853	-901
19	142	137	58	-21	429	-178	-1113	-549	-1077	-903	-1368	-816	-947	-732	-1202	-631	-1186	-869	-1358	-1327
-27	87	71	-7	-32	298	-159	-689	-243	-650	-571	-881	-504	-529	-394	-697	-305	-724	-550	-908	-925
3	15	32	-57	10	168	-96	-287	13	-232	-196	-357	-156	-135	-67	-237	-17	-250	-201	-386	-420
73	-15	37	-48	43	111	-2	-75	77	-24	1	-74	44	7	41	-32	57	-14	3	-69	-91

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-169	-131	-249	-124	-150	-237	-324	-357	-191	-107	-21	-24	-65	-272	-194	-88	46	12	-90	-2	-16
-369	-315	-506	-276	-304	-465	-617	-599	-415	-328	23	25	-157	-472	-451	-187	82	-94	-194	11	-47
-612	-508	-731	-468	-480	-726	-897	-795	-665	-553	53	52	-248	-656	-687	-280	74	-185	-326	-7	-90
-867	-687	-949	-669	-658	-951	-1144	-991	-897	-776	21	38	-320	-820	-932	-350	62	-279	-464	-28	-144
-1147	-854	-1180	-896	-862	-1195	-1408	-1169	-1156	-995	-40	23	-387	-978	-1187	-406	46	-359	-607	-56	-225
-646	-485	-780	-455	-508	-772	-922	-814	-671	-578	133	112	-241	-695	-846	-232	216	-146	-385	19	-35
-196	-109	-331	-66	-184	-322	-403	-388	-216	-169	290	170	-163	-345	-427	-56	286	16	-176	61	82
-636	-477	-732	-456	-503	-748	-899	-797	-663	-565	160	110	-281	-657	-794	-214	185	-163	-372	23	-50
-1140	-842	-1165	-847	-973	-1190	-1389	-1165	-1144	-989	18	48	-400	-967	-1193	-375	77	-356	-618	-43	-212
-659	-483	-778	-463	-524	-799	-938	-815	-677	-579	177	123	-264	-696	-858	-208	236	-151	-412	20	-34
-199	-101	-331	-65	-185	-321	-405	-381	-215	-173	326	182	-175	-339	-450	-46	315	32	-180	66	95
-26	45	-85	20	-23	-35	-51	-21	-16	-48	411	171	-101	-81	-205	-9	212	24	-98	72	97

S12	S13	S14	S15	S16
-63	-18	45	-137	-80
-148	-69	25	-373	-210
-249	-161	-7	-591	-357
-350	-252	-67	-745	-491
-431	-427	-146	-867	-634
-264	-147	54	-718	-398
-67	69	152	-547	-155
-257	-132	9	-711	-386
-436	-403	-122	-893	-651
-269	-144	47	-767	-407
-68	81	157	-565	-160
35	78	133	-421	-51

TABLE B3 CONTINUED

ELEMENT 31X UNDER ACTION T_x

STRESS T_x lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-213.27	-85.5	12.0	-16.1	32	-5	19	2	27	-1	32	8	39	3	54	-5	44	-2	0	1	14
-436.60	-176.4	15.9	-22.6	58	-11	37	-26	46	-28	62	20	51	8	81	-4	74	-5	0	1	8
-660.94	-264.0	24.9	-27.7	87	-1	56	-33	78	-49	92	33	61	3	100	2	93	-3	1	8	6
-884.73	-357.7	29.6	-26.8	115	7	71	-59	102	-84	120	48	75	-5	123	0	113	-20	7	-5	4
-662.40	-269.0	24.7	-19.0	93	3	53	-43	78	-54	98	45	77	3	103	4	95	-3	4	0	0
-214.97	-91.2	9.4	-1.9	35	2	22	-28	28	-21	31	8	51	0	59	-8	54	-18	3	-13	9
-663.26	-267.7	24.4	-24.2	82	12	50	-48	72	-56	96	43	66	6	103	9	96	-3	4	-1	10
-886.74	-360.0	34.7	-26.9	109	30	66	-43	101	-72	121	65	70	3	125	12	115	-8	7	1	0
-661.40	-268.0	26.4	-21.1	83	22	53	-35	73	-51	93	52	63	12	102	16	92	-3	-1	2	4
-213.50	-130.4	12.8	-10.0	42	11	30	-25	31	-9	36	18	44	5	60	7	55	-8	9	-10	21

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-6	0	-14	-6	17	1	-10	-52	-64	-70	-71	-111	-157	-36	-57	-62	-71	-69	-101	-95	-139
-4	-1	-21	-15	28	5	-2	-128	-140	-141	-160	-215	-298	-73	-126	-146	-152	-140	-180	-191	-272
23	-9	-10	-18	64	17	22	-212	-204	-213	-230	-306	-419	-126	-154	-236	-233	-220	-275	-277	-384
41	-9	-24	-23	88	32	45	-298	-301	-287	-321	-382	-537	-185	-287	-328	-323	-293	-378	-351	-505
25	-16	-21	-27	67	14	27	-218	-206	-216	-238	-300	-427	-126	-195	-237	-235	-223	-283	-280	-397
-2	-9	-20	-21	11	-6	0	-59	-55	-69	-74	-108	-166	-26	-54	-71	-74	-70	-98	-112	-148
28	-18	-18	-27	65	9	28	-217	-202	-218	-237	-304	-429	-120	-199	-239	-230	-218	-276	-275	-391
60	-19	-3	-27	103	31	62	-297	-293	-297	-324	-381	-540	-178	-281	-334	-314	-298	-383	-362	-500
34	-17	-11	-33	75	9	34	-217	-191	-220	-231	-300	-429	-116	-191	-242	-232	-225	-283	-285	-394
0	-6	-25	-21	10	-6	-2	-63	-47	-74	-69	-107	-165	-34	-44	-67	-68	-71	-98	-111	-148

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-47	-97	-70	-90	-71	-96	-104	-154	-58	-102	-1	-7	6	-99	-39	-48	-30	-20	-30	-28	-3
-118	-183	-176	-192	-157	-166	-196	-294	-154	-227	-8	-5	9	-173	-87	-106	-108	-81	-67	-41	-18
-179	-280	-290	-301	-242	-241	-276	-401	-238	-350	-21	4	17	-242	-146	-159	-198	-147	-95	-44	-45
-247	-382	-415	-412	-336	-332	-348	-518	-343	-465	-43	4	28	-322	-192	-202	-289	-204	-131	-65	-65
-177	-278	-292	-305	-248	-265	-278	-432	-238	-351	-26	9	27	-256	-136	-151	-194	-141	-115	-54	-50
-58	-98	-73	-98	-91	-106	-111	-193	-60	-118	-14	12	16	-99	-26	-40	-40	-19	-51	-34	-2
-185	-281	-289	-303	-247	-255	-277	-428	-236	-359	-23	24	22	-255	-143	-153	-202	-149	-104	-42	-44
-255	-379	-418	-412	-343	-340	-350	-529	-345	-476	-43	21	28	-321	-183	-197	-291	-207	-134	-53	-61
-185	-279	-290	-303	-247	-257	-280	-432	-241	-351	-25	30	28	-256	-121	-146	-189	-148	-114	-42	-40
-55	-94	-1068	-97	-79	-100	-106	-192	-63	-101	0	20	19	-100	-30	-39	-45	-19	-42	-24	5

S12	S13	S14	S15	S16
6	3	-39	-23	-6
6	-19	-118	-67	-63
-12	-51	-191	-114	-130
-40	-79	-278	-163	-196
-17	-52	-206	-110	-119
-12	-2	-70	-15	-10
-15	-54	-205	-113	-117
-30	-78	-280	-167	-182
-4	-56	-197	-116	-108
1	3	-61	-7	1

TABLE B3 CONTINUED

ELEMENT 32 UNDER ACTION τ_1

STRESS τ_1 lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-212.39	-103.6	14.1	-28.3	25	0	2	0	-42	42	-33	97	17	37	-24	37	-26	43	4	98	-16
-433.55	-228.6	25.5	-37.7	65	0	34	-13	-34	57	-24	148	49	54	-22	42	-19	45	39	141	-4
-655.67	-355.7	37.6	-52.2	102	11	76	-22	-25	74	3	179	76	52	-15	41	-8	39	78	165	17
-881.79	-491.8	49.3	-76.0	126	26	121	-26	1	83	35	221	101	46	-5	39	4	28	110	182	44
-1102.34	-622.2	62.3	-88.2	159	37	172	-15	19	95	68	259	135	42	6	25	19	16	145	196	61
-661.48	-367.6	41.1	-46.4	111	11	101	-14	2	50	27	184	93	56	-1	28	10	29	93	154	38
-213.09	-111.2	19.6	-8.0	37	-10	29	-4	-12	17	2	114	39	39	-3	17	0	35	29	89	1
-658.78	-363.9	40.4	-42.1	103	5	91	-12	-3	61	16	195	89	53	-5	30	6	32	81	156	31
-1104.29	-625.5	64.7	-89.6	168	38	177	-22	26	106	66	271	144	41	11	24	33	15	143	203	64
-659.94	-365.2	43.6	-38.9	109	19	105	-9	3	50	29	193	99	58	0	25	11	27	91	161	43
-213.74	-112.2	22.6	-6.2	51	0	33	-2	-12	21	0	117	47	41	0	18	1	35	32	97	11
-2.84	-3.0	16.5	9.0	16	15	26	15	11	0	20	64	12	16	18	14	23	20	23	24	-18

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
4	-15	3	-13	28	-21	63	-99	-97	-98	-80	-73	-76	-114	-114	-116	-122	-85	-84	-71	-83
-5	-12	5	-36	55	-46	125	-218	-193	-195	-187	-162	-196	-266	-264	-242	-248	-184	-184	-163	-200
-20	11	-2	-44	80	-60	191	-339	-298	-298	-299	-251	-318	-407	-409	-373	-383	-285	-289	-256	-317
-25	24	-9	-59	104	-62	236	-475	-423	-404	-427	-346	-459	-546	-571	-514	-521	-387	-399	-363	-455
-37	46	-4	-55	121	-58	276	-606	-533	-493	-544	-427	-616	-686	-740	-642	-661	-480	-513	-446	-590
-33	13	-15	-64	82	-58	207	-355	-303	-284	-302	-230	-326	-416	-421	-386	-394	-284	-290	-261	-332
0	-9	-6	-42	34	-33	106	-115	-62	-84	-80	-62	-85	-133	-107	-124	-127	-80	-84	-74	-81
-23	10	-14	-53	76	-46	197	-352	-296	-292	-300	-244	-333	-417	-416	-386	-385	-290	-283	-254	-320
-33	47	-14	-58	115	-45	276	-615	-536	-501	-544	-425	-608	-688	-746	-641	-661	-481	-511	-453	-594
-29	21	-17	-43	72	-43	201	-356	-294	-289	-297	-231	-330	-418	-421	-385	-386	-279	-286	-254	-323
3	-8	-11	-41	38	-30	111	-117	-60	-89	-81	-69	-86	-138	-98	-123	-123	-86	-74	-75	-75
31	-6	8	-11	11	0	40	-19	35	-4	6	10	5	-15	8	-6	6	-7	8	-6	7

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-139	-147	-198	-130	-120	-71	-43	-57	-109	-161	-26	-60	-33	-21	-89	-65	-161	-104	1	-30	-15
-287	-309	-433	-269	-255	-181	-127	-143	-228	-341	-64	-135	-65	-69	-153	-157	-254	-205	-20	-89	-32
-442	-466	-693	-408	-380	-286	-213	-247	-360	-517	-131	-197	-123	-108	-230	-263	-362	-299	-41	-149	-52
-588	-638	-934	-556	-503	-414	-304	-382	-483	-701	-197	-279	-169	-175	-293	-385	-451	-397	-61	-213	-65
-727	-811	-1171	-704	-640	-521	-396	-501	-597	-879	-271	-365	-215	-239	-355	-496	-531	-475	-81	-310	-83
-456	-489	-765	-427	-390	-278	-217	-268	-367	-552	-116	-223	-115	-144	-216	-309	-328	-300	-57	-165	-59
-168	-151	-279	-142	-129	-72	-51	-64	-123	-179	7	-59	-13	-52	-82	-113	-119	-101	-12	-28	-16
-453	-470	-735	-422	-383	-273	-220	-278	-369	-531	-122	-198	-115	-129	-226	-281	-336	-281	-51	-154	-61
-727	-814	-1173	-714	-631	-526	-400	-504	-600	-897	-270	-361	-229	-247	-367	-502	-523	-469	-75	-301	-93
-459	-487	-772	-425	-387	-296	-214	-263	-365	-538	-111	-211	-112	-140	-216	-304	-323	-288	-46	-161	-61
-176	-148	-296	-137	-129	-74	-48	-65	-130	-181	13	-47	-9	-49	-87	-104	-114	-89	-9	-13	-21
-17	-3	-62	-3	-16	5	1	0	1	-10	24	27	9	-12	-14	-35	24	19	15	21	-10

S12	S13	S14	S15	S16
3	-113	-34	-141	-19
-37	-210	-91	-239	-49
-75	-300	-159	-452	-90
-132	-365	-229	-536	-121
-193	-435	-295	-712	-164
-77	-301	-159	-503	-79
5	-136	-47	-222	-20
-78	-295	-155	-404	-90
-195	-435	-234	-723	-165
-90	-302	-166	-504	-92
18	-143	-37	-236	-1
25	-39	-1	-63	22

TABLE B3 CONTINUED

ELEMENT 33 UNDER ACTION T_s

STRESS T_s lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-209.82	-175.6	17.5	-45.4	0	20	-51	87	-107	97	-183	181	-24	112	-80	116	-79	180	-151	208	-37
-436.06	-371.7	35.5	-81.6	31	38	-27	111	-73	126	-166	200	-22	146	-89	139	-70	224	-158	256	-35
-658.64	-572.3	53.8	-133.7	58	64	-4	163	-67	166	-142	235	-30	174	-59	152	-63	264	-166	290	-20
-881.33	-777.8	72.7	-176.8	88	94	10	199	-40	187	-109	265	-32	159	-94	159	-51	294	-170	319	2
-1104.30	-980.7	91.7	-233.0	99	118	30	234	-1	226	-69	299	-32	215	-93	166	-40	327	-171	336	24
-660.37	-590.5	59.1	-140.9	79	58	12	153	-36	154	-117	246	-22	170	-89	156	-53	278	-174	296	-7
-211.32	-196.3	24.6	-54.8	31	20	-27	81	-83	102	-153	183	-20	110	-81	139	-75	206	-180	230	-33
-658.56	-580.9	56.9	-138.6	66	62	5	160	-48	165	-123	238	-20	168	-89	151	-52	270	-180	295	-16
-1103.91	-982.2	93.8	-232.9	107	126	36	240	7	225	-66	296	-30	221	-88	162	-37	331	-178	333	28
-658.48	-593.2	58.6	-142.2	81	69	13	158	-36	158	-117	246	-23	167	-89	149	-50	267	-171	289	-11
-213.44	-194.0	26.5	-52.8	42	29	-23	91	-82	108	-144	192	-19	111	-82	144	-73	205	-187	231	-38
1.04	-12.2	9.7	-5.4	0	21	-17	57	-43	52	-38	86	-13	19	-45	65	-60	94	-127	125	-32

INDIVIDUAL VALUES OF STRAIN (microstrain)

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
59	-58	85	-54	65	-8	32	-195	-106	-343	-121	-180	-99	-166	-214	-210	-128	-206	-190	-155	-153
107	-64	131	-42	86	49	40	-400	-254	-650	-249	-402	-255	-378	-459	-458	-298	-394	-377	-339	-335
144	-66	171	-36	118	107	65	-628	-427	-940	-387	-622	-435	-594	-710	-682	-493	-563	-565	-516	-526
192	-60	208	-16	138	169	86	-868	-603	-1224	-515	-855	-630	-835	-952	-917	-696	-733	-768	-702	-726
233	-61	236	-3	169	225	130	-1120	-788	-1459	-655	-1088	-811	-1079	-1185	-1158	-902	-901	-954	-895	-912
155	-59	176	-38	114	117	66	-646	-453	-965	-382	-641	-448	-618	-744	-702	-527	-570	-580	-531	-540
78	-52	100	-65	76	-4	33	-216	-127	-396	-126	-214	-105	-188	-249	-242	-183	-225	-207	-175	-168
156	-64	174	-38	109	115	68	-648	-435	-962	-386	-642	-430	-613	-711	-703	-518	-564	-567	-522	-519
234	-57	244	-6	166	224	139	-1119	-792	-1506	-660	-1103	-810	-1089	-1182	-1155	-899	-894	-957	-882	-906
155	-65	176	-38	111	112	70	-660	-454	-975	-387	-653	-443	-624	-739	-707	-537	-566	-579	-531	-537
82	-55	105	-65	75	-5	35	-215	-125	-401	-124	-209	-96	-189	-247	-246	-170	-214	-197	-165	-153
34	-21	28	-37	14	-17	32	-13	-18	-46	-7	-12	5	-16	-10	-21	-34	-17	-4	-1	0

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-144	-134	-213	-188	-204	-187	-99	-179	-118	-271	-153	-45	-179	-98	-148	12	-156	-37	-30	-167	-138
-316	-310	-449	-411	-389	-366	-219	-347	-266	-577	-279	-99	-285	-236	-220	-110	-217	-229	-92	-265	-264
-498	-494	-672	-640	-564	-563	-360	-533	-444	-871	-420	-162	-393	-365	-303	-239	-299	-427	-167	-341	-389
-680	-661	-881	-878	-736	-773	-496	-726	-627	-1172	-570	-234	-480	-510	-359	-361	-397	-604	-244	-422	-487
-878	-837	-1084	-1120	-893	-968	-624	-917	-817	-1440	-732	-301	-582	-643	-504	-497	-510	-800	-312	-488	-598
-504	-496	-679	-671	-577	-598	-364	-551	-458	-915	-435	-187	-404	-409	-252	-253	-291	-444	-173	-367	-397
-155	-140	-234	-195	-232	-201	-101	-177	-126	-316	-161	-83	-203	-160	-123	-1	-122	-60	-46	-172	-178
-507	-485	-672	-657	-570	-578	-362	-535	-460	-886	-431	-177	-405	-407	-314	-237	-304	-427	-172	-348	-398
-887	-828	-1095	-1137	-995	-978	-623	-913	-821	-1440	-743	-298	-586	-647	-509	-479	-525	-785	-319	-482	-612
-511	-489	-678	-677	-585	-600	-365	-546	-468	-916	-451	-185	-410	-416	-301	-237	-298	-435	-179	-361	-398
-155	-138	-230	-210	-236	-208	-98	-171	-125	-324	-161	-75	-192	-164	-127	4	-116	-51	-42	-163	-184
-12	1	-18	5	-18	-21	9	-6	-4	-27	-7	-21	-37	-23	-39	60	-31	46	4	-7	-46

S12	S13	S14	S15	S16
-30	-116	99	-58	-20
-70	-236	117	-128	-119
-113	-341	119	-179	-203
-177	-440	94	-223	-312
-243	-526	92	-247	-434
-133	-339	141	-161	-215
-28	-145	169	-67	-34
-131	-342	125	-165	-217
-255	-507	99	-245	-439
-141	-335	149	-166	-220
-33	-147	173	-60	-23
-5	-38	81	-21	14

TABLE B3 CONTINUED

ELEMENT 51 UNDER ACTION S

STRESS S lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
3.02	3.3	3.5	21.2	0	2	2	7	-2	2	2	-6	32	C	2	3	2	7	4	1	6
4.67	2.0	1.1	26.4	0	5	2	3	0	0	3	-15	20	4	2	0	1	8	-1	-2	3
9.09	0.5	0.9	68.0	2	1	-3	1	2	-3	0	-19	17	4	0	0	4	5	-8	-5	9
17.95	0.5	-4.5	279.7	6	7	-6	0	3	-7	-2	-9	14	-4	-5	-9	6	11	-20	7	15
26.52	-3.2	-6.2	1047.5	16	8	-5	-2	1	-6	-17	-21	16	-14	-17	-20	9	12	-36	17	10
-0.02	-2.7	-5.9	862.9	21	16	-11	0	1	-1	-14	-26	-11	-1	-17	8	6	5	-24	19	-11
26.40	-2.6	-8.5	1043.6	28	9	-15	-3	3	-3	-16	-12	5	-9	-14	-23	8	17	-33	14	10

INDIVIDUAL VALUES OF STRAIN (microstrain)

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
8	0	1	0	-3	4	-4	0	-6	4	-4	5	12	6	-1	0	-5	6	15	5	6
9	-1	-3	0	2	2	1	3	-11	0	-2	8	2	2	0	-3	0	4	9	4	3
12	1	-10	-1	-7	5	5	4	-10	-8	-6	12	0	3	0	-1	-6	9	18	6	9
15	-9	-15	1	2	3	8	28	0	-33	8	20	-8	-2	-20	-2	-24	27	2	12	-12
-3	-24	-35	13	-1	5	19	57	55	-54	17	31	-11	4	-12	36	-24	46	3	31	-23
-17	-21	-18	15	10	6	1	45	20	-51	34	7	9	3	1	6	4	23	-28	19	-30
-1	-21	-35	12	-4	2	16	60	42	-56	18	30	-16	-5	-6	28	-23	47	1	26	-21

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
2	-7	-2	16	3	4	10	0	-7	8	21	-7	22	18	22	11	14	15	-12	8	-5
0	-9	-2	5	-4	-1	16	-6	-10	6	22	2	30	20	30	21	12	18	-19	32	-18
2	-23	0	2	1	1	12	2	-20	0	42	7	48	44	61	52	22	24	-37	6	-41
-2	-40	18	-19	0	-25	19	0	-53	-8	125	66	153	195	171	239	45	87	-99	-100	-167
-17	-50	14	-57	20	-55	15	-4	-105	-75	355	307	628	702	7CC	796	135	276	-241	-353	-659
-15	-16	-7	-42	-17	1	-16	0	-69	-31	276	266	536	587	592	616	90	195	-184	-267	-587
-14	-51	9	-65	2	-45	17	-7	-104	-73	348	310	623	712	692	796	130	272	-237	-363	-655

S12	S13	S14	S15	S16
-7	-14	-17	-12	0
-10	-20	-6	-15	-1
-49	-36	-24	-31	-12
-246	-124	-138	-96	-55
-793	-576	-700	-328	-293
-605	-591	-555	-271	-244
-789	-564	-690	-333	-299

TABLE B3 CONTINUED

ELEMENT 52 UNDER ACTION S

STRESS S lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
4.29	1.8	4.6	32.5	0	2	3	4	-3	-4	-5	-3	4	-6	1	8	1	-1	0	3	6
8.62	3.8	6.7	110.9	10	5	16	3	3	-5	-3	0	20	-19	9	-2	0	-7	0	-6	32
13.24	7.0	6.9	153.6	[illegible]	6	13	0	-5	-10	-5	0	24	-15	11	3	2	-6	1	12	41
17.63	10.2	5.1	266.0	7	12	20	11	-5	-2	-2	3	32	-17	15	13	-2	-1	0	16	59
22.20	11.9	7.5	466.0	7	10	23	7	-8	-3	0	12	44	-10	24	14	-3	-8	-4	20	90
0.0	8.3	7.8	320.6	9	0	10	3	-7	0	6	22	25	-4	16	5	-3	-3	-3	9	65
22.02	11.6	1.4	504.7	1	8	20	1	-8	-4	3	15	46	-6	26	4	-5	-5	-8	22	98
33.26	15.0	-3.1	1994.5	-9	-2	25	0	-9	11	18	36	50	-11	39	3	-21	-12	-35	41	224
44.21	15.4	-8.9	6512.5	-9	-23	30	-1	-8	51	28	56	55	15	55	16	-31	-11	-79	44	330

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
3	3	3	6	-6	11	6	1	-3	0	4	-5	-12	35	-33	7	0	2	6	0	8
10	6	6	-4	-11	7	19	-4	0	-9	-14	24	-5	28	-71	9	2	37	21	-6	-18
24	6	12	-5	-4	17	34	-11	-6	-5	-11	23	-3	31	-103	18	6	27	35	-10	-20
29	13	14	-16	-5	13	34	-7	0	-10	-20	28	0	28	-136	4	18	32	42	-11	-36
44	16	16	-37	-9	8	27	-9	-3	-19	-22	38	-9	19	-164	16	41	38	66	-13	-37
41	12	18	-36	-3	-11	25	20	-11	-26	-14	60	-18	56	-154	2	40	41	39	14	-42
49	22	17	-42	-10	9	23	-3	-43	-10	-41	55	-21	15	-202	17	48	42	58	1	-62
75	36	28	-66	-15	-39	-8	-30	-92	-57	-80	45	-22	-69	-334	19	163	44	103	-16	-145
125	63	47	-121	-20	-153	-98	-64	-211	-115	-171	-49	-43	-344	-640	-9	395	62	197	-36	-303

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
10	3	10	2	13	4	8	16	9	6	31	3	30	11	29	8	31	6	-15	5	-18
9	-4	15	7	25	-2	32	30	19	14	48	3	121	49	96	56	72	20	-34	-19	-79
-4	-16	19	5	30	-2	42	47	27	26	63	17	151	70	116	81	92	36	-37	-34	-97
-15	-37	19	5	35	-7	43	65	33	35	96	50	225	166	180	160	120	61	-57	-50	-167
-19	-55	19	6	42	0	59	80	44	45	147	102	357	309	347	298	160	92	-86	-83	-330
1	-42	10	6	36	24	38	52	19	14	101	64	234	253	253	248	57	43	-25	-40	-226
-6	-77	23	-9	46	0	62	32	50	45	149	100	381	360	390	339	155	82	-82	-83	-368
0	-196	27	1	43	37	126	124	130	72	566	473	1210	1298	1551	1418	536	402	-385	-373	-1524
43	-329	139	75	167	154	258	204	258	175	2002	1828	3742	4092	4798	4425	1717	1574	-1421	-1502	-4783

S12	S13	S14	S15	S16
-13	-23	-9	-33	-12
-26	-49	-48	-34	-19
-43	-117	-103	-67	-39
-112	-194	-130	[illegible]	-91
-241	-301	-338	-152	-153
-205	-172	-272	-86	-122
-290	-307	-379	-159	-161
-1394	-1150	-1361	-619	-666
-4418	-3760	-4160	-2155	-2231

TABLE B3 CONTINUED

ELEMENT 53 UNDER ACTION S

STRESS — MEAN VALUES — INDIVIDUAL VALUES OF STRAIN (microstrain)

S lb/in	ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
4.36	5.0	3.1	37.1	-22	33	-2	9	14	8	14	10	-13	15	-3	12	8	0	1	0	6
8.74	9.5	6.2	111.5	-10	37	-3	20	2	8	25	10	-9	17	-6	22	10	9	13	5	27
13.49	11.6	8.3	356.7	4	56	-3	31	-8	5	22	15	3	27	-14	48	7	7	4	-2	25
17.94	13.8	8.4	484.9	6	66	-2	49	-9	5	22	21	4	42	-17	48	8	9	0	6	37
22.14	17.5	16.9	1019.8	43	120	3	74	-20	-4	10	1	13	45	-16	55	6	6	-4	-3	42
-0.01	16.1	19.5	812.8	50	119	3	51	-6	-5	-18	-10	8	67	-11	56	15	14	-11	-15	6
22.71	20.4	24.6	1308.2	70	150	8	76	-29	-4	6	-16	27	50	-17	60	12	1	-9	-4	49
33.13	26.2	31.5	4328.4	162	359	39	135	-75	-30	-95	-101	62	95	-6	85	-3	-20	-57	-30	51
44.37	30.5	32.3	10550.7	220	536	83	191	-110	-52	-226	-203	96	142	31	125	-16	-42	-116	-69	58

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
1	2	2	0	8	-2	15	-13	-15	-23	-2	-14	9	4	27	7	-12	37	-14	1	2
-2	12	7	2	18	3	11	-10	-11	-8	9	3	13	12	15	3	-10	34	-5	-7	2
14	13	13	0	5	3	0	-6	-8	-5	36	4	17	9	-1	0	-19	26	4	-36	31
16	13	16	-4	3	5	-16	-8	-4	-23	59	-13	30	13	-2	-7	-15	10	8	-48	24
19	15	22	-1	0	13	-21	6	8	-1	121	-5	66	21	-1	-16	-20	8	27	-68	52
27	9	11	6	15	1	1	16	0	5	83	0	46	21	9	20	3	27	35	-35	78
21	12	19	1	4	16	-16	5	0	-11	152	-3	95	25	5	-5	-16	15	39	-66	77
22	12	41	11	-19	15	-24	-58	-40	-53	316	-13	286	69	71	-83	-32	-49	38	-122	149
-9	38	56	43	-35	10	0	-284	-145	-71	445	32	523	219	207	-163	-39	-121	20	-141	122

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-6	25	-34	12	22	15	15	-1	4	10	-10	19	38	0	109	7	26	10	14	-7	-32
3	18	-34	21	24	26	21	0	1	9	21	24	108	22	193	34	78	14	3	-19	-106
-20	43	-41	24	8	15	19	20	1	56	90	36	287	166	396	233	179	46	-59	-31	-321
-29	55	-40	25	6	9	19	30	0	70	129	52	393	242	484	321	228	80	-94	-49	-419
-43	56	-26	33	-19	-1	10	55	-5	100	256	133	759	574	859	781	412	179	-229	-128	-797
-25	51	-28	40	-34	21	-1	41	2	70	159	111	579	521	654	683	293	165	-106	-81	-587
-45	74	-10	75	-33	6	2	44	1	123	328	198	966	763	1079	995	501	262	-296	-172	-977
-129	95	101	109	-170	29	-102	48	-62	264	1000	975	2979	2596	3129	3227	1485	1071	-1119	-807	-2965
-203	7	209	335	-258	22	-211	-3	-184	459	2439	2575	6881	6348	7471	7706	3380	2916	-2898	-2460	-7184

S12	S13	S14	S15	S16
-13	-25	-9	-37	13
-35	-98	-24	-67	-10
-181	-298	-179	-141	-35
-257	-393	-247	-183	-60
-615	-803	-603	-343	-164
-525	-652	-552	-269	-110
-909	-1000	-813	-404	-227
-2809	-3225	-2732	-1153	-1068
-7040	-7311	-6506	-2798	-2732

TABLE B3 CONTINUED

ELEMENT 113 UNDER ACTION S

STRESS S lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
4.36	1.7	0.4	36.9	4	2	7	6	0	0	6	16	1	-11	0	10	2	-8	3	-3	3
8.83	2.4	0.6	68.3	4	8	12	7	4	0	13	9	0	-19	1	13	0	-6	2	-4	10
13.39	2.1	-1.4	122.8	3	4	17	5	6	-6	26	16	0	-27	0	12	0	-13	0	-6	13
17.98	1.1	-3.0	240.5	1	10	16	1	7	-7	27	17	3	-26	0	2	-3	-15	-2	-2	19
22.14	2.6	-1.2	450.4	7	16	16	-2	7	-6	42	8	8	-22	0	8	-2	-16	-11	-9	20
0.20	1.4	-4.2	304.8	10	-2	24	-6	1	0	-3	14	6	4	4	7	1	-14	-6	-11	12
22.28	2.7	-8.0	453.7	5	20	18	-6	10	-8	36	15	6	-16	-2	6	-6	-19	-11	-4	20
33.30	-0.7	-20.5	1307.6	15	36	12	1	7	-11	22	-20	14	-25	0	5	2	-35	-19	-22	19
44.72	-3.9	-26.7	3346.9	22	55	18	0	12	-5	10	-72	22	-35	0	3	2	-53	-21	-55	25
55.92	-3.2	-31.5	6274.5	26	65	28	16	18	0	-6	-123	34	-37	0	10	6	-66	-25	-77	28

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
3	3	-6	5	-1	0	-6	-9	-8	4	20	0	12	5	6	-2	0	-4	0	2	4
5	5	-8	4	0	-3	-5	-12	-9	2	27	-3	12	9	8	1	-2	-10	-5	1	1
6	6	-6	6	-1	-3	-12	-27	-8	6	25	0	16	7	11	-1	3	-16	-19	-5	-2
5	9	-9	8	0	-13	-23	-55	-10	7	38	-2	23	4	10	-3	1	-30	-14	0	0
16	11	-7	15	-1	-15	-23	-66	1	0	56	-3	20	8	15	3	2	-36	-15	0	3
-1	12	-6	13	-8	0	-19	-34	-6	-3	28	-6	16	3	-1	18	-9	-15	-16	-3	-12
12	16	-5	14	0	-15	-23	-71	-3	2	35	-13	15	9	0	3	-5	-32	-39	-3	-16
23	19	-20	22	-11	-16	-35	-124	-34	6	50	-11	19	7	-19	12	-8	-57	-62	-10	-13
4	22	-18	30	-4	-15	-42	-191	-81	28	48	9	26	30	-28	26	-7	-66	-112	4	3
0	25	-13	37	15	-6	-40	-297	-143	43	48	19	47	47	-40	24	-8	-74	-119	24	58

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
7	12	-7	-17	-3	-2	-9	-3	-1	-7	10	8	18	42	21	29	14	27	-20	-5	-13
1	17	-13	-4	-6	3	-11	-5	0	2	27	15	-36	59	48	44	33	43	-36	-19	-34
8	6	-19	-7	-15	-2	-17	-1	-5	19	43	17	63	111	87	50	49	51	-52	-29	-63
14	7	-30	-9	-19	2	-20	-8	-5	19	77	43	105	192	177	145	83	95	-91	-55	-124
20	19	-32	-8	-26	6	-19	-11	-5	25	153	102	207	318	337	315	144	155	-145	-107	-255
13	8	-17	-19	-26	2	-15	-5	-4	-2	74	74	133	224	235	224	81	106	-73	-69	-173
19	12	-37	-21	-31	3	-16	-23	1	14	139	94	220	312	346	315	144	139	-158	-106	-260
41	20	-57	-50	-65	-19	-29	-32	-4	16	431	343	651	832	998	884	372	380	-385	-351	-838
70	61	-71	-67	-97	-45	-16	-183	17	19	1126	926	1816	2017	2505	2142	916	967	-951	-982	-2245
114	152	-56	-97	-108	-132	-10	-286	46	14	2078	1808	3629	3853	4630	4202	1762	1923	-1826	-1927	-4302

S12	S13	S14	S15	S16
-18	-24	-26	-8	-5
-40	-54	-53	-31	-24
-58	-77	-87	-59	-36
-139	-144	-171	-102	-69
-263	-270	-305	-172	-132
-214	-157	-227	-105	-118
-259	-274	-304	-187	-147
-809	-768	-841	-490	-419
-2126	-1953	-2104	-1153	-1054
-4060	-3751	-3962	-2157	-995

TABLE B3 CONTINUED

ELEMENT 12[illegible] UNDER ACTION S

STRESS S lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
6.63	3.9	-0.7	36.1	3	8	3	0	4	5	0	4	2	5	0	5	8	4	9	-2	13
8.78	5.8	0.0	74.3	5	2	7	5	5	9	5	3	4	6	6	C	8	5	6	0	21
13.12	6.4	-0.1	160.3	24	9	2	7	8	2	5	0	12	13	4	-9	5	12	3	4	30
17.66	7.5	-2.8	243.7	31	19	10	6	10	0	3	0	19	10	7	-4	13	16	9	9	33
22.16	7.9	-4.8	495.4	40	29	15	10	-1	7	-2	2	22	9	7	C	5	24	6	21	23
0.10	3.7	2.8	332.7	35	15	17	0	-1	0	7	-11	11	-9	19	-11	6	11	3	0	4
22.04	8.4	-2.7	551.6	43	27	4	14	-1	7	0	0	22	7	5	-8	5	30	2	15	23
33.26	9.3	-9.9	1788.9	75	83	2	37	-21	-3	-43	3	25	11	9	-1	4	45	-11	15	1
44.14	4.7	-16.8	4409.0	114	125	3	49	-49	-11	-84	2	22	-3	15	-12	-5	21	-25	9	-40
55.11	2.5	-23.4	8217.6	125	175	3	59	-54	-27	-112	-17	4	-19	11	-15	-7	38	-28	5	-87

X18	X19	X20	X21	X22	X23	X24		Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
0	1	5	3	4	0	3	[illegible]	-7	1	0	1	-11	-13	0	5	4	20	16	-9	13
2	5	6	9	8	-4	1	[illegible]	-12	3	1	-3	-2	-12	0	10	0	22	15	-9	15
2	3	-1	3	10	-9	-1	[illegible]	0	17	13	-7	10	-23	5	17	-8	14	11	-5	17
-8	3	-6	3	13	-10	-7	[illegible]	-13	19	7	-8	6	-36	11	24	-11	22	18	-8	19
-13	-2	-14	13	4	-7	-11	[illegible]	-17	25	23	-6	16	-51	0	40	-15	41	22	-12	6
-23	5	-10	15	2	9	-4	19	10	35	15	-10	23	-15	6	26	-12	13	19	1	13
-11	1	-14	12	10	-10	-8	8	-7	27	26	-13	32	-58	23	42	-5	27	36	-18	10
-21	-11	-20	22	14	-13	-4	-20	35	40	75	-6	33	-97	18	85	-10	44	25	-44	2
-43	-15	-38	33	22	-15	7	-36	37	29	112	-27	50	-161	-30	131	85	29	22	-84	-15
-75	-13	-38	35	35	-19	42	-24	[illegible]	2	133	-64	90	-230	-75	181	217	15	4	-137	-24

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
0	5	-2	10	-1	-21	-4	0	-22	-11	17	1	40	3	54	12	35	2	-25	5	-38
2	2	-15	21	0	-7	-6	-2	-34	-5	54	5	77	4	59	19	48	0	-40	-8	-76
1	6	-13	32	-5	-3	-4	-23	-52	-24	98	15	172	16	214	40	80	-4	-80	-1	-186
3	8	-9	37	1	-12	-8	-32	-71	-45	132	33	225	77	265	72	97	17	-98	-23	-227
3	-10	-18	61	-10	-12	-14	-36	-99	-70	209	113	399	236	457	181	157	106	-164	-90	-388
3	-5	0	46	-16	-8	-7	-40	-18	-44	131	78	298	179	321	124	87	75	-73	-41	-286
9	-1	-29	71	-18	-14	-17	-33	-100	-72	223	140	453	271	512	192	170	107	-188	-90	-438
0	27	-40	123	-64	25	-64	-52	-203	-160	556	536	1267	1019	1408	873	481	465	-506	-398	-1260
-3	95	-57	191	-96	35	-129	-56	-340	-222	1226	1451	3018	2650	3177	2328	1277	1216	-1264	-1104	-3021
-24	165	-98	287	-129	222	-157	-46	-460	-365	2475	2766	5479	4933	5705	4389	2458	2271	-2448	-2181	-5588

S12	S13	S14	S15	S16
2	-44	15	-52	12
5	-87	17	-73	4
-5	-184	0	-120	-6
-43	-253	-44	-163	-66
-152	-428	-195	-266	-174
-108	-276	-144	-161	-117
-160	-438	-209	-306	-193
-834	-1393	-952	-756	-681
-2312	-3140	-2490	-1622	-1555
-4395	-5650	-4593	-3003	-4038

TABLE B3 CONTINUED

ELEMENT 21 UNDER ACTION S

STRESS S lb/in²	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
4.33	0.0	-1.0	24.2	0	4	1	8	0	-5	-4	0	-1	-1	2	0	6	2	2	0	5
8.74	-1.6	2.2	51.1	0	8	0	3	-1	0	-7	-5	-5	-5	0	0	0	-3	0	-5	0
13.13	-3.2	1.2	73.1	1	6	0	0	0	-7	-10	-10	-12	-10	0	0	3	0	-3	-5	0
17.75	-0.7	0.5	112.1	-1	19	5	0	-3	-1	-9	-5	-14	3	-2	1	5	5	-2	-4	1
22.16	-2.0	5.5	114.8	-3	20	0	2	-4	0	-11	-21	-17	-10	-2	1	0	-1	0	-8	15
0.11	-0.5	4.3	26.9	-2	18	7	1	4	5	-4	-11	-6	-7	4	2	5	2	3	-9	6
21.95	-3.3	2.7	139.5	-5	18	0	0	-4	10	-13	-15	-15	-3	0	1	4	-12	0	-11	2
33.23	-4.1	1.8	256.4	-15	24	2	1	-6	2	-13	-11	-19	-12	-3	3	0	2	-4	-20	1
44.37	-8.1	2.4	482.8	-24	29	1	1	-11	1	-14	-17	-17	-8	-5	0	-1	-17	-8	-20	0
55.35	-8.2	6.8	954.3	-32	33	1	6	-15	6	-15	-13	-17	5	-5	-2	5	-9	-15	-25	-4
88.44	-16.3	46.8	5582.9	-33	57	-2	-1	-14	-3	-16	-31	-19	-9	-6	-38	24	-39	-7	-38	-32

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-6	6	-13	-7	0	-2	3	2	-12	-4	4	6	9	-15	1	0	0	-3	12	-10	-1
-4	3	-9	-6	0	-5	3	0	-7	-4	9	8	16	-14	24	4	11	-5	13	-5	-2
-13	10	-9	-6	-2	-9	1	2	10	-9	9	-11	31	-52	44	9	11	-1	11	-15	14
-5	9	-8	-3	0	-11	3	-5	12	-3	14	-11	28	-59	43	11	13	-5	10	-14	8
-6	14	0	-2	-4	-12	7	3	7	-2	23	-19	31	-52	59	23	17	3	28	-13	6
-16	15	-11	-3	-7	1	-11	-1	4	-3	12	-6	27	-52	56	12	8	-3	28	-16	23
-12	12	-11	-6	-8	-11	2	2	7	-5	3	-23	26	-65	61	22	2	-2	32	-15	14
-2	19	-15	0	-11	-21	0	11	14	-2	0	-26	28	-48	68	39	21	2	25	-20	4
-13	19	-29	-7	-19	-27	-7	26	16	2	-8	-24	19	-66	72	58	36	-1	20	-21	-8
-14	21	-39	0	-26	-28	-11	51	22	17	-2	-21	-8	-60	42	87	55	7	24	-12	-22
-68	19	-86	19	-22	-2	-36	91	69	91	-12	25	-105	-74	-60	250	188	87	76	13	19

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-7	-4	-2	-1	-3	0	0	-7	1	1	26	0	30	0	38	-4	18	-7	-18	0	-37
-6	-2	-5	-6	0	-7	1	9	6	0	45	-5	60	2	65	3	32	-1	-35	-8	-52
-15	0	-2	-7	0	-7	2	-7	9	-11	62	-11	79	1	84	1	29	20	-49	-7	-77
-12	0	0	-19	0	0	-2	-4	5	-3	79	2	96	23	101	19	43	39	-65	-20	-93
-9	2	7	-23	0	7	3	3	14	-7	106	11	121	29	129	33	63	51	-75	-24	-109
0	8	-6	0	0	-15	4	8	7	0	20	-10	22	9	19	22	7	25	3	-8	-3
-11	-4	10	-20	4	-2	0	2	10	0	75	24	99	57	97	59	41	63	-54	-45	-78
-21	-24	15	-58	7	4	0	-7	10	-18	129	71	158	108	164	109	83	132	-83	-88	-126
-22	-27	23	-73	9	4	21	-3	17	-4	227	154	295	231	289	208	161	203	-119	-141	-227
-22	-28	39	-110	25	9	47	12	9	7	397	300	623	515	596	460	310	352	-248	-275	-478
3	65	84	-252	152	130	148	140	-68	7	2024	1606	3872	3454	3558	3230	1628	1558	-1584	-1603	-3343

S12	S13	S14	S15	S16
0	-23	6	-25	-2
-6	-37	0	-44	-16
0	-66	5	-71	-35
-10	-82	-4	-34	-80
-27	-97	-13	-113	-91
-7	1	3	-32	-60
-46	-77	-35	-38	-109
-96	-149	-93	-178	-140
-181	-304	-238	-315	-341
-441	-613	-527	-525	-497
-3223	-3606	-3413	-2219	-1432

TABLE B3 CONTINUED

ELEMENT 22? UNDER ACTION S

STRESS S lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
4.29	0.9	4.0	34.3	-7	-1	3	7	4	-27	3	7	7	-3	3	-9	3	3	2	14	-6
8.70	1.8	11.9	65.6	-2	-16	2	11	3	-27	4	4	12	0	3	-12	3	4	0	30	-3
13.24	2.2	6.8	108.8	-13	-14	4	17	0	-29	0	3	11	2	0	-10	-5	5	4	52	-11
17.68	3.8	7.6	157.1	-7	-9	7	22	-4	-21	4	0	16	7	0	-8	-6	13	-2	63	0
22.12	5.7	8.8	229.7	-12	1	5	19	-2	-26	-2	0	16	6	5	-8	0	10	0	80	-5
0.0	2.5	8.8	92.8	3	1	7	19	-1	-36	0	-22	3	1	1	-12	10	6	-4	57	-9
22.12	4.5	7.0	225.6	-15	-4	1	19	-5	-32	-1	-6	14	7	0	-9	-3	10	-3	78	0
33.23	4.8	7.9	533.9	-13	14	3	25	-34	-22	-19	-6	11	10	-4	-8	-12	13	-10	94	-14
66.44	9.0	2.6	3903.4	-29	35	15	50	-84	-19	-56	13	-9	12	-18	-1	-33	25	13	182	-102
88.70	11.9	-16.3	8914.6	-26	62	20	70	-84	-7	-66	19	-28	-2	-23	0	-20	47	54	249	-231

INDIVIDUAL VALUES OF STRAIN (microstrain)

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-4	15	0	-4	11	0	-3	9	19	4	-36	-3	3	17	3	1	-22	-7	0	2	-1
1	6	2	0	9	5	2	3	40	6	57	0	23	26	10	0	11	-9	3	-5	13
11	9	0	-1	9	1	3	-1	35	0	40	-4	9	19	9	1	-30	-19	0	-9	12
1	9	-2	-1	6	3	2	2	27	5	43	1	31	24	16	4	-33	-20	12	-7	15
6	5	3	-3	6	5	24	3	13	8	34	-1	42	23	31	-3	-6	-29	31	-14	35
-5	2	-4	1	9	17	16	19	41	11	14	-3	15	7	23	19	-16	1	28	16	12
7	10	2	2	11	6	16	9	20	11	18	-8	37	2	30	4	-45	-28	40	-13	29
1	-5	6	-6	15	12	64	22	31	26	41	-2	59	0	66	-5	-5	-53	62	-26	46
-50	-68	3	14	68	67	188	95	-89	141	163	-68	189	-142	119	-90	-42	-218	106	-10	164
-185	-93	4	42	127	102	250	56	-261	165	293	-105	155	-240	69	-158	-119	-283	131	-11	253

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
1	15	7	13	12	17	9	14	-8	6	28	3	36	4	29	13	34	20	-33	-3	-41
-1	15	-6	10	8	18	11	19	-8	12	42	12	54	15	58	32	49	24	-47	-11	-63
-6	17	-8	8	7	20	4	27	-10	22	61	27	89	42	77	53	72	26	-62	-24	-89
-2	6	-17	8	-5	25	10	21	-23	15	85	25	125	87	112	86	89	37	-71	-22	-133
-2	11	-24	-9	-4	32	0	27	-35	24	111	46	174	132	153	115	113	50	-105	-73	-175
-4	5	-7	-20	-5	23	-10	11	0	7	42	9	85	93	79	59	33	11	-18	-26	-34
-11	17	-20	2	-3	29	0	28	-18	17	101	51	167	141	154	125	94	56	-99	-79	-154
-7	15	-53	-2	-21	28	-19	19	-47	21	194	136	366	381	340	318	171	159	-180	-171	-322
151	84	-174	10	-96	-15	-107	-31	-157	87	1095	1220	2620	2663	2536	2357	963	1171	-1015	-1283	-2500
275	278	-204	16	-79	-14	-175	-47	-443	75	2583	2767	5950	5884	5742	5370	2227	2619	-2302	-2902	-5732

S12	S13	S14	S15	S16
10	-27	4	-21	8
1	-47	-7	-54	5
-4	-78	-27	-92	-4
-12	-112	-53	-117	-13
-36	-170	-99	-145	-34
-4	-74	-49	-68	-23
-42	-156	-90	-137	-55
-194	-376	-297	-246	-165
-2172	-2709	-2453	-1252	-1157
-5093	-6011	-5594	-3033	-2759

TABLE B3 CONTINUED

ELEMENT 23S UNDER ACTION S

STRESS S lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
4.49	4.0	0.1	29.4	6	9	2	-2	0	0	-3	-7	9	3	2	0	6	1	1	2	17
9.04	6.0	0.3	102.2	13	16	0	0	-4	-2	2	-8	5	4	-3	0	13	11	14	-1	27
13.29	7.5	0.1	138.1	19	19	-2	0	-3	4	4	-13	9	8	0	2	15	12	6	-10	42
17.86	9.2	-21.8	208.9	25	25	-3	1	-4	9	10	-17	16	8	-5	5	9	15	4	-8	45
22.30	9.3	-1.2	317.1	31	29	-7	8	-12	12	2	-17	21	14	-9	8	13	14	2	-22	46
-0.05	9.1	5.6	156.2	25	6	10	1	1	4	5	2	14	10	-3	4	17	17	-4	-3	20
22.14	16.2	0.1	321.5	42	39	0	12	-5	16	18	-15	25	18	0	7	20	21	5	-19	44
44.32	21.0	-23.8	1732.8	69	67	6	16	-34	47	20	-21	33	36	-1	10	52	20	-12	-44	59
66.52	21.2	-75.8	5439.1	77	80	11	18	-49	78	-13	-29	31	18	-4	-4	80	54	-26	-48	23
88.60	26.0	-138.6	10970.1	101	99	27	27	-32	101	-51	-44	30	-23	-2	-22	136	95	-16	-46	-44

STRESS	X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
4.49	5	12	1	6	8	3	4	-4	15	-9	2	-1	14	3	4	-7	0	0	-5	-5	1
9.04	2	10	0	16	10	3	12	-15	32	-10	1	-17	25	0	10	-4	12	-10	0	-11	2
13.29	3	18	-5	16	15	3	12	-11	28	-22	0	-31	26	0	29	-5	2	-5	3	-17	1
17.86	5	16	-5	22	14	4	21	-11	29	-36	5	-39	34	-15	30	-4	3	-9	9	-21	4
22.30	0	12	-11	31	28	-4	29	-21	42	-41	6	-42	41	-28	20	-2	2	-15	11	-35	13
-0.05	-11	15	0	24	34	7	16	36	30	-8	7	-24	9	-9	0	9	10	-7	2	-8	11
22.14	-4	22	-15	37	76	7	32	-6	47	-51	7	-39	37	-20	19	2	3	-7	7	-24	0
44.32	-42	9	-37	78	83	2	86	-116	112	-118	-31	-121	34	-113	46	19	-40	-58	-4	-94	-3
66.52	-135	-17	-73	137	125	26	149	-314	155	-259	-56	-271	0	-189	56	-7	-127	-132	-33	-173	-23
88.60	-245	-28	-123	236	164	86	201	-574	73	-383	-161	-366	-67	-170	48	-43	-161	-167	-62	-210	-75

STRESS	Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
4.49	-1	-9	-5	0	-1	7	4	-1	-9	0	25	0	42	2	43	0	23	0	-27	-5	-34
9.04	9	-6	-5	8	-21	10	6	3	-28	1	53	22	88	31	107	37	49	9	-65	-15	-98
13.29	11	-24	12	11	-20	19	9	4	-38	2	72	29	110	55	141	54	64	27	-81	-25	-120
17.86	18	-26	9	26	-18	19	5	19	-60	-491	99	39	160	96	184	142	83	48	-108	-38	-156
22.30	17	-19	14	34	-28	34	3	24	-80	4	136	76	234	164	263	172	117	83	-144	-54	-222
-0.05	23	10	1	11	-14	11	13	4	-12	5	57	24	142	94	154	117	60	30	-32	-9	-100
22.14	30	-37	12	27	-13	23	15	21	-64	0	151	66	253	153	281	162	127	72	-153	-53	-223
44.32	38	-13	1	121	-64	71	-10	56	-226	-36	660	511	1290	1023	1020	939	578	474	-688	-368	-978
66.52	43	26	-36	139	-105	79	-13	47	-505	-138	2002	1808	3922	3355	3050	3081	1766	1625	-2102	-1448	-3135
88.60	41	52	-97	178	-116	37	33	-32	-703	-330	3828	3614	7521	6606	5963	6091	3406	3302	-3986	-3161	-6171

STRESS	S12	S13	S14	S15	S16
4.49	9	-28	11	-25	-2
9.04	-18	-77	-11	-54	-42
13.29	-35	-96	-16	-65	-56
17.86	-62	-147	-52	-91	-70
22.30	-123	-234	-121	-136	-104
-0.05	-59	-131	-61	-56	-55
22.14	-109	-239	-108	-143	-121
44.32	-869	-1299	-1004	-697	-566
66.52	-3017	-3924	-3352	-2127	-912
88.60	-6098	-7495	-6729	-4065	-3875

TABLE B3 CONTINUED

ELEMENT 31 UNDER ACTION S

STRESS S lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
65.94	-2.6	4.5	367.5	17	32	-11	-1	-19	-5	-17	8	-12	19	-11	-13	0	0	-6	21	-2
132.74	-4.4	28.4	805.4	42	46	-16	-16	-38	-11	-28	4	-5	41	-26	-24	-8	5	-19	48	4
198.80	-7.4	55.0	1293.6	59	70	-17	-30	-53	-11	-46	0	-1	58	-43	-41	-10	16	-31	60	-4
264.77	-24.3	85.2	1870.2	68	-28	-7	-53	-63	-4	-72	-20	-27	-72	-47	-44	-3	26	-37	59	-41
133.73	-18.4	54.3	1148.2	41	-8	-1	-44	-32	-2	-40	-40	-25	-63	-32	-26	-1	17	-36	18	-17
0.0	-9.8	-1.8	205.8	10	-39	6	-23	-2	-1	0	-21	-12	-34	-5	-18	8	-5	-10	-37	-3
132.80	-14.9	27.4	963.2	35	-19	-5	-24	-34	-9	-41	4	-12	-42	-24	-24	4	10	-25	13	-23
263.48	-26.8	83.4	1929.0	76	-46	5	-72	-59	-8	-85	-22	-12	-98	-33	-65	5	17	-36	55	-57

INDIVIDUAL VALUES OF STRAIN (microstrain)

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-8	-17	-21	2	-6	-2	-4	-18	0	16	1	3	2	39	-9	0	-21	42	-22	35	4
-13	-44	-23	1	-9	-11	-3	4	20	33	23	9	28	102	-26	51	-5	93	-45	71	21
-41	-66	-28	0	-13	-9	5	23	50	40	51	-2	32	203	-33	112	18	126	-66	108	28
-154	-89	-14	10	-23	9	46	63	83	42	41	3	42	314	-36	165	31	152	-84	135	24
-119	-60	1	6	-8	-12	47	91	30	43	1	3	9	178	-42	117	29	102	-54	91	-6
-37	-17	4	9	-3	-22	22	40	-48	25	-47	19	-51	0	-43	36	-19	39	-23	34	-28
-70	-51	-19	7	-13	-6	15	31	-11	42	-34	8	-3	118	-21	86	-21	109	-72	90	-19
-165	-82	-18	20	-10	18	32	88	34	70	0	11	46	298	-23	198	1	190	-121	176	-19

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
0	-12	30	22	6	24	-8	0	-40	-18	-217	-113	-202	-188	-217	-146	-183	-128	185	167	248
1	7	84	113	-16	112	-24	27	-61	2	-402	-223	-433	-418	-462	-340	-372	-261	437	382	544
12	25	169	206	-48	202	-43	71	-72	16	-595	-367	-688	-694	-725	-566	-566	-439	688	618	850
35	0	258	360	-30	241	-13	80	-69	85	-799	-567	-951	-1066	-971	-955	-789	-712	990	806	1161
11	-10	137	251	-48	195	-20	68	-47	88	-412	-370	-557	-702	-582	-643	-466	-449	565	506	702
-7	-32	-21	50	-35	53	-16	18	-8	-1	-19	-83	-83	-178	-98	-161	-100	-125	58	48	133
17	-50	71	211	-28	123	-2	8	-45	-4	-375	-334	-427	-608	-436	-563	-390	-446	426	471	567
79	-12	256	356	-5	201	17	30	-60	72	-647	-752	-783	-1341	-754	-1234	-681	-896	845	956	1038

S12	S13	S14	S15	S16
161	224	152	178	130
389	507	366	404	283
671	800	620	642	469
1051	1092	976	860	707
719	660	646	472	422
172	129	131	33	42
576	523	535	376	389
1268	958	1139	711	905

TABLE B3 CONTINUED

ELEMENT 325 UNDER ACTION 5

STRESS	MEAN VALUES			INDIVIDUAL VALUES OF STRAIN (microstrain)																
S lb/in	ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
66.49	10.8	8.0	347.9	18	-7	27	-29	36	-18	25	-3	29	8	26	-18	30	-3	32	-5	49
132.71	12.4	23.2	785.3	63	-25	62	-68	74	-40	27	-33	56	34	46	-41	66	-9	37	-60	88
199.27	22.2	37.0	1359.6	92	-17	95	-102	114	-69	38	-50	81	87	80	-75	104	-11	96	-84	139
265.05	28.1	51.7	2116.8	123	-32	146	-114	156	-68	54	-105	100	102	100	-98	141	0	150	-128	142
133.88	8.2	25.9	1379.0	41	-87	111	-89	103	-42	43	-97	29	52	30	-92	80	10	118	-74	70
3.15	-3.9	1.0	338.4	-8	-59	53	-2	24	-8	2	-53	-6	-7	-10	-33	8	9	34	-10	-2
132.83	14.3	31.0	1097.0	50	-40	83	-46	83	-20	25	-48	46	32	40	-60	66	12	82	-66	67
264.62	29.4	52.9	2180.4	118	-40	153	-103	162	-56	47	-103	92	101	87	-103	141	6	157	-135	133

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
18	23	0	27	-7	21	-24	56	-7	27	-27	60	-69	68	-56	48	3	32	-23	22	0
51	41	-16	52	-25	47	-130	102	76	17	-31	110	-151	98	-67	149	97	77	-41	28	-4
90	59	-43	83	-47	78	-203	103	136	40	-78	157	-262	150	-108	268	160	162	-90	63	-28
136	91	-88	121	-74	108	-289	103	153	90	-176	241	-426	201	-186	399	223	271	-164	122	-56
78	43	-87	79	-42	92	-174	-11	101	53	-159	121	-262	102	-107	226	186	191	-125	90	-39
46	12	-32	15	-19	14	-62	-47	-16	36	-111	9	-72	-22	4	20	60	42	-44	9	4
98	49	-48	60	-30	61	-156	77	62	58	-109	137	-238	110	-69	196	183	132	-77	49	-10
163	79	-85	123	-66	116	-281	106	135	100	-203	266	-457	222	-210	409	250	287	-166	121	-60

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
17	-11	16	-25	12	-11	27	0	22	-22	198	172	213	216	172	156	181	96	-99	-174	-145
40	-5	22	-95	29	5	37	5	30	-21	394	454	474	578	331	419	332	220	-182	-387	-279
83	-6	89	-175	67	-15	63	8	69	-34	655	975	799	1034	501	771	452	404	-260	-694	-424
167	-37	190	-252	74	44	41	74	116	-51	919	1701	1092	1816	636	1299	499	677	-270	-1161	-516
133	-37	150	-311	19	24	0	74	90	56	547	1174	721	1283	340	856	185	414	-124	-795	-302
24	-7	65	-160	-27	26	-30	59	15	159	112	311	194	376	37	212	-53	70	14	-241	-58
70	-24	107	-226	16	30	13	46	102	47	494	872	578	934	322	640	283	325	-134	-619	-269
163	-54	218	-273	66	63	35	72	134	-40	919	1809	1084	1922	612	1368	486	697	-236	-1238	-486

S12	S13	S14	S15	S16
-212	-174	-215	-94	-157
-574	-365	-532	-177	-356
-1074	-542	-971	-254	-682
-1796	-690	-1616	-345	-1311
-1274	-420	-1088	-190	-929
-348	-136	-262	-69	-245
-908	-398	-817	-197	-671
-1913	-583	-1721	-345	-1419

TABLE B3 CONTINUED

ELEMENT 33 UNDER ACTION S

STRESS S lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN (microstrain) X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
65.94	21.0	17.2	448.9	33	9	11	-11	4	13	21	102	7	-8	1	16	-10	32	15	77	16
130.89	46.7	30.1	993.8	74	2	37	-26	9	8	67	237	12	-3	20	24	-20	64	52	158	32
197.69	82.1	42.2	1627.6	116	20	68	-30	48	6	197	269	33	12	55	36	-17	74	100	269	84
264.65	124.7	44.3	2415.1	186	19	99	-29	85	45	333	369	71	27	100	43	-21	115	132	389	117
136.20	80.5	31.3	1579.4	131	9	83	-27	45	28	241	263	64	65	89	15	-21	85	52	255	60
0.0	19.1	10.9	317.2	45	10	72	-14	11	46	73	72	35	40	50	-20	14	6	-2	24	-1
131.94	61.3	44.9	1250.9	107	28	78	-23	44	41	180	181	50	11	66	6	-10	37	68	181	62
264.96	126.4	55.4	2479.6	194	44	105	-32	86	53	373	349	87	42	108	37	-23	106	124	376	139

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
49	13	33	24	2	8	35	-4	-50	0	78	-14	-3	21	4	54	-17	43	32	51	39
100	32	59	38	-2	32	108	-15	-151	-1	143	-41	25	36	9	58	-64	79	38	127	70
151	62	69	37	6	66	231	-22	-242	23	87	-99	106	22	23	63	-119	124	57	236	93
211	94	74	32	6	132	355	-76	-351	49	78	-167	182	21	15	60	-193	176	88	363	84
106	66	58	-10	0	63	203	-40	-212	44	30	-153	190	6	57	-48	-139	98	61	258	27
-13	19	9	-21	-8	-15	24	-19	47	0	24	-104	118	-15	77	-90	-53	22	9	74	-28
90	57	27	12	-7	30	146	-9	-81	21	74	-134	166	-5	73	49	-109	117	61	218	20
192	101	63	23	10	129	338	-82	-315	59	85	-214	243	-14	53	49	-176	178	118	388	88

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
58	5	8	18	44	-26	51	-35	-9	22	120	254	103	390	167	443	89	312	-81	-219	-112
123	12	40	35	86	-12	83	-32	-77	93	296	528	289	836	431	879	215	658	-213	-483	-334
208	-22	84	40	148	12	120	2	-254	249	675	664	714	1107	1006	1199	558	855	-534	-673	-837
256	-81	163	37	239	-14	170	12	-420	296	956	969	1073	1639	1555	1832	754	1233	-788	-993	-1287
153	-41	149	0	144	9	93	53	-294	246	556	645	672	1149	988	1271	377	848	-495	-672	-831
27	-29	79	3	32	15	26	23	-73	56	106	156	148	230	200	270	-7	212	-109	-136	-172
171	-37	92	65	125	21	89	46	-214	186	536	511	606	781	867	884	394	642	-455	-476	-702
260	-64	161	72	245	17	159	68	-454	320	1065	955	1193	1577	1707	1785	833	1173	-898	-957	-1448

S12	S13	S14	S15	S16
-501	-84	-298	-32	-247
-1068	-234	-638	-120	-444
-1484	-631	-791	-419	-415
-2301	-889	-1205	-601	-574
-1692	-524	-825	-331	-315
-426	-64	-169	-35	-10
-1160	-472	-567	-341	-258
-2243	-1007	-1112	-686	-509

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT A5Y UNDER ACTION T_1

STRESS T_1 lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-184.85	2.6	-142.4	-44.8	-10	-12	0	4	-1	15	-12	30	-1	-13	-4	-17	-8	11	-6	1	8
-550.22	6.2	-442.8	-106.0	-9	-7	-3	26	-6	25	-6	11	12	0	1	18	-10	19	-4	-18	14
-370.56	6.3	-314.1	-82.5	-6	0	-2	28	-3	8	-14	5	4	0	0	20	-4	19	-6	-7	11
0.47	3.7	-39.0	-23.0	-3	12	0	12	0	0	3	1	0	19	0	10	0	4	-6	2	2
-185.36	8.5	-165.1	-62.5	-5	3	-2	21	2	19	0	19	-5	17	4	8	-1	14	-2	5	7
-552.07	7.8	-450.2	-116.5	-6	-6	0	29	-1	21	5	-1	16	1	3	16	-7	13	2	-21	17

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-17	0	28	8	6	42	13	68	-356	94	-456	39	-452	57	-379	15	-235	9	-158	23	-255
-12	15	20	0	20	53	-8	228	-1042	298	-1335	190	-1292	153	-1163	143	-894	100	-638	127	-889
-7	3	25	6	20	52	0	143	-730	194	-916	102	-937	88	-848	70	-556	50	-431	71	-604
-9	-1	9	2	5	15	8	-10	-50	-19	-60	-18	-85	-30	-114	-47	1	-25	-17	-14	-41
-5	2	23	9	9	52	9	51	-376	81	-486	33	-480	19	-468	-22	-213	-12	-160	22	-285
-10	18	21	3	18	60	-5	181	-1009	256	-1307	165	-1275	121	-1202	83	-812	52	-626	105	-895

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
32	-294	-29	-99	-8	-217	-26	-175	-19	-132	124	-374	314	-466	200	-312	81	-203	-87	91	-250
131	-962	-104	-437	-67	-712	-136	-506	-154	-424	138	-842	414	-801	188	-679	52	-382	-110	34	-237
77	-665	-101	-294	-52	-507	-108	-360	-107	-280	121	-659	377	-643	187	-519	61	-292	-118	85	-247
3	-83	-94	6	-43	-13	-36	18	-39	43	-1	-144	50	-58	-27	12	3	-10	-31	30	-32
40	-324	-98	-94	-46	-217	-62	-182	-51	-83	127	-411	296	-467	134	-327	71	-204	-105	111	-248
98	-958	-158	-407	-101	-666	-177	-480	-186	-402	131	-843	386	-805	125	-654	41	-368	-112	25	-244

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
129	-194	3	-80	100	16	11	70	-10	-14	19	21	16	22	35	22	-1	44	77	51	-52
-137	-38	-481	-41	-100	0	-50	84	-308	-47	-54	23	-4	51	36	57	-122	61	41	73	-22
-11	-111	-248	-65	-24	-25	-39	22	-183	-92	-45	-43	-32	29	-4	7	-87	37	34	59	-23
40	-57	51	-23	19	-12	77	12	-57	-27	-52	29	-23	13	55	17	67	23	82	28	37
126	-198	13	-95	89	11	41	63	-88	4	-22	14	-54	34	47	44	16	75	91	63	54
-119	-61	-416	-72	-111	-6	-119	68	-348	-29	-90	5	-139	81	-26	65	-119	58	44	95	-52

S1	S2	S7	S8	S9	S10	S15	S16
116	-42	85	-64	-72	187	-32	116
78	-79	94	-57	-60	211	-30	-39
73	-70	94	-54	-62	179	-63	36
35	-14	28	34	-11	51	17	42
101	-86	106	-53	-66	139	-28	73
74	-84	86	-63	-42	155	-52	-21

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

FLEMENT B1Y UNDER ACTION T_x

STRESS	MEAN VALUES			INDIVIDUAL VALUES OF STRAIN																
T_x lb/in	ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-185.33	0.9	-159.9	16.5	25	-6	4	3	-9	12	-54	40	8	-21	3	-4	0	5	24	21	3
-558.22	4.6	-479.4	22.6	38	7	2	6	-2	16	-81	51	16	-2	7	2	6	4	53	24	18
-374.47	4.6	-321.9	18.4	31	0	0	14	-5	16	-81	51	19	-10	6	6	4	13	42	19	16
-0.28	1.7	4.4	-2.7	8	1	4	1	-1	-1	0	20	4	-8	9	-2	1	5	11	-7	13
-186.31	2.9	-155.6	11.3	29	0	0	9	-5	12	-50	50	11	-19	10	-1	0	9	38	12	13
-558.96	9.2	-477.7	9.2	40	18	5	16	0	18	-74	63	22	-6	12	5	6	13	56	16	21

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-36	3	-7	-3	-1	27	-16	-47	-187	-99	-236	-112	-192	-152	-210	-53	-161	-105	-130	-84	-208
-65	-2	-14	1	4	63	-45	9	-782	-145	-813	-203	-709	-293	-787	-151	-693	-249	-485	-238	-627
-50	-1	-11	6	4	52	-36	-27	-491	-136	-531	-172	-446	-247	-464	-103	-432	-186	-289	-174	-400
-38	0	3	0	3	5	2	3	5	32	-37	21	-19	10	-14	20	-3	16	22	19	18
-45	0	-9	-3	1	33	-25	-34	-214	-81	-263	-92	-224	-135	-218	-41	-175	-93	-128	-79	-193
-57	2	-4	4	10	62	-33	5	-792	-138	-805	-198	-721	-278	-780	-168	-679	-265	-473	-245	-603

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-125	-156	-162	-137	-105	-136	-177	-167	-174	-156	2	-70	10	-97	-34	-146	-56	-134	-140	-14	-209
-349	-481	-555	-336	-416	-375	-521	-422	-537	-397	-58	-329	-60	-377	-133	-375	-57	-279	-291	-34	-446
-259	-294	-366	-244	-265	-264	-354	-283	-366	-270	-40	-200	-17	-226	-78	-263	-86	-217	-225	-28	-355
1	-3	-17	22	-2	4	3	27	-22	12	2	-25	39	12	0	-30	-2	-10	-26	13	-16
-127	-153	-155	-124	-113	-133	-170	-169	-175	-155	-5	-104	40	-92	-9	-159	-45	-161	-140	-10	-200
-364	-473	-580	-311	-430	-362	-532	-408	-549	-374	-55	-350	-45	-382	-136	-382	-141	-283	-300	-39	-452

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-97	-95	-89	19	1	-53	-22	-18	-4	3	-199	-9	-83	7	-151	22	-44	98	-65	92	-144
-267	-174	-439	55	-211	26	-345	81	-54	23	-738	-1	-403	-212	-274	-57	-208	142	-137	66	-335
-178	-142	-236	35	-111	-70	-143	6	-13	4	-472	-6	-207	-75	-256	-23	-125	150	-96	76	-261
0	17	40	-19	-11	-3	24	12	11	11	-50	14	-32	62	-38	48	-1	71	-24	99	-49
-97	-78	-71	14	-20	-70	-54	-13	-18	-1	-280	-22	-134	26	-185	9	-80	93	-89	70	-169
-250	-179	-433	56	-220	18	-337	100	-48	21	-763	-28	-422	-169	-297	-37	-205	124	-149	63	-322

S1	S2	S7	S8	S9	S10	S15	S16
52	-47	11	-143	-49	75	49	0
65	-202	39	-239	-79	71	91	-207
57	-107	39	-194	-60	63	66	-81
12	-29	58	12	-6	19	-19	19
40	-71	19	-140	-47	55	13	-24
58	-202	29	-223	-80	72	74	-199

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT C2Y UNDER ACTION T_x

STRESS T_x lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-186.23	2.6	-161.2	33.5	3	-2	0	-1	1	1	-12	15	9	-2	4	1	3	3	1	9	0
-559.76	11.1	-533.8	134.2	25	-22	13	6	8	21	-60	66	34	15	40	-6	-9	6	-14	37	50
-375.10	7.1	-351.0	112.7	23	-12	10	6	3	15	-62	62	35	11	34	-2	-14	8	-12	30	43
0.00	5.7	18.4	36.0	3	9	4	2	12	9	-5	26	22	7	11	16	1	6	8	16	20
-185.92	6.7	-158.2	82.6	17	5	11	8	8	11	-38	47	25	1	22	6	-8	18	0	14	20
-559.40	8.6	-528.8	128.4	25	-29	13	0	8	27	-56	66	27	25	30	3	-9	18	-13	28	33

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-16	7	1	0	8	39	-10	1	-420	7	-376	-340	-324	-25	-324	-20	-307	0	-305	517	-261
-54	71	3	-4	13	42	-18	-509	-780	-404	-685	-372	-629	-475	-670	-460	-678	-435	-639	100	-528
-47	56	-29	-7	-5	33	-10	-438	-467	-327	-410	-313	-324	-402	-349	-357	-404	-317	-360	202	-294
-29	29	-17	-1	-2	-20	6	-30	-47	-24	-11	-8	17	-33	3	-42	49	24	6	538	16
-36	38	-17	-7	0	5	8	-177	-269	-138	-235	-143	-191	-184	-173	-182	-168	-115	-188	414	-183
-62	52	-14	-12	7	30	3	-341	-971	-252	-858	-217	-815	-291	-843	-324	-802	-271	-817	302	-714

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-32	-256	-16	-230	-68	-139	-116	-213	-117	-192	-18	-98	-12	-172	-14	-97	-41	-133	-67	-85	-56
-476	-470	-249	-622	-469	-271	-661	-330	-750	-205	-183	-191	-391	-169	-289	-27	-151	-283	-369	-35	-314
-370	-257	-154	-434	-351	-158	-512	-178	-589	-88	-153	-68	-324	-14	-230	46	-136	-199	-287	12	-245
22	-37	42	-6	-43	13	-35	-13	-38	-40	148	-71	83	-18	77	-47	0	-77	-76	59	-112
-122	-205	-92	-168	-181	-84	-218	-153	-209	-162	11	-56	-85	-22	-65	17	-130	-88	-114	-41	-142
-248	-686	-279	-569	-423	-329	-493	-507	-517	-455	-46	-345	-160	-396	-138	-189	-164	-280	-283	-127	-283

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-179	-3	-258	37	-194	38	-155	30	-272	29	-191	-6	-193	8	-152	25	25	34	-86	-4	-11
-407	-234	-682	-126	-467	81	-385	-23	-403	137	-345	-142	-372	76	-553	-60	31	40	-65	-188	-66
-276	-169	-500	-90	-309	72	-230	-21	-253	102	-194	-129	-149	45	-417	-58	44	57	-14	-143	-75
69	-101	42	-94	53	5	-18	-51	-119	-36	-23	-70	19	1	-31	-25	53	10	20	-41	-91
-150	-101	-235	-78	-143	21	-142	-59	-240	11	-108	-134	-40	5	-143	-50	29	11	-63	-51	-129
-407	-221	-675	-144	-479	65	-486	-21	-622	88	-536	-173	-532	2	-411	-88	27	53	-176	-104	-196

S1	S2	S7	S8	S9	S10	S15	S16
11	-140	-60	-127	-37	-3	43	-97
-70	-209	-71	-274	-147	78	111	-262
-78	-112	-108	-208	-99	80	111	-173
-6	-92	-39	2	-15	22	-5	-29
-36	-65	-160	-62	-20	-18	55	-105
-8	-332	-111	-231	-91	42	81	-276

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT DGY UNDER ACTION τ_x

STRESS τ_x lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-184.32	6.6	-173.1	25.0	16	8	-5	6	3	12	4	2	15	23	3	-8	14	23	8	-7	0
-556.26	13.6	-526.6	74.7	27	11	-14	6	27	21	7	0	23	37	-13	-10	18	43	18	4	0
-279.56	11.8	-351.4	47.5	27	4	-11	-1	6	-1	-3	-28	7	21	-21	-48	-4	-7	-10	-53	-18
0.04	-1.9	-5.3	-2.8	7	-11	-2	-5	-5	6	0	-2	-6	8	-4	-18	4	-1	-2	4	-1
-185.22	-0.0	-175.4	26.8	13	-13	-13	-6	-1	10	0	-2	2	32	-11	-11	8	22	-6	-4	-5
-557.67	7.0	-536.8	84.1	25	-9	-18	-9	16	18	1	0	14	59	-20	-28	15	42	7	-4	-2

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
11	1	23	0	3	-9	4	-4	-371	10	-271	-47	-224	-74	-295	-68	-236	-59	-259	-60	-295
24	5	60	5	18	-10	14	-39	-1095	18	-888	-72	-750	-171	-1009	-176	-789	-104	-863	-117	-955
-33	-25	-19	-30	-58	-60	-60	-61	-839	-76	-1218	9	-626	-510	-793	-382	-646	452	-152	-520	-1280
-6	0	0	-8	-7	1	1	15	-76	21	-52	-1	-46	11	-14	-2	-13	0	-11	-4	-32
9	-7	11	-8	-9	-14	3	-8	-375	10	-297	-33	-277	-62	-310	-76	-258	-44	-286	-48	-333
17	2	52	-4	5	-16	5	-35	-1133	31	-930	-56	-820	-157	-1036	-149	-825	-71	-920	-91	-1030

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-68	-284	-93	-189	-182	-271	-106	-166	-123	-265	-39	-131	-32	-136	-37	-115	4	-28	-48	-98	-55
-140	-895	-251	-633	-411	-757	-329	-562	-370	-777	-72	-514	-34	-456	-67	-381	-25	-211	-182	-338	-178
-536	-1254	-323	-762	83	-521	25	-252	-165	-989	-3	-160	83	-248	-16	-215	377	-519	-178	-442	-238
-7	-40	-21	4	-8	9	-36	0	-34	-5	-16	-6	13	-2	6	3	1	3	-12	-1	0
-75	-315	-116	-196	-175	-269	-140	-178	-148	-254	-50	-151	-13	-153	-28	-113	6	-53	-72	-97	-60
-101	-967	-238	-693	-383	-801	-322	-628	-352	-809	-67	-532	7	-466	-35	-401	-3	-268	-191	-330	-181

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-136	-41	-137	-25	-173	25	-412	18	-239	-16	-167	17	-197	-105	4	-151	-198	-111	-39	-106	-186
-504	-102	-512	-60	-497	8	-1093	15	-867	-60	-561	-38	-789	-263	-131	-279	-486	-247	-172	-324	-369
-485	-326	-373	30	-452	-937	-1326	-520	-238	-669	-821	-548	-334	-999	1234	198	-903	-1056	-522	99	1371
24	18	12	-1	-18	-70	-96	-69	-119	-66	-209	-72	23	-162	-14	-109	18	-156	-19	-99	-69
-136	-27	-152	-39	-194	-73	-416	-48	-355	-103	-359	-82	-259	-244	-73	-244	-163	-248	-65	-245	-179
-513	-101	-540	-87	-499	-81	-1091	-42	-922	-113	-701	-87	-813	-355	-171	-316	-543	-323	-207	-408	-432

S1	S2	S7	S8	S9	S10	S15	S16
-16	-115	19	-7	-66	-59	-27	-162
-51	-393	-30	-63	-244	-173	-79	-455
88	305	383	1552	-44	385	755	625
-38	12	-41	26	-31	-1	-49	17
-76	-95	-49	-17	-118	-48	-100	-141
-86	-416	-28	-101	-289	-172	-131	-421

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT ESY UNDER ACTION T_x

STRESS T_x lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-186.36	7.0	-224.6	21.0	13	9	16	6	1	-2	17	-20	22	60	11	10	1	5	27	-17	-13
-563.63	17.5	-713.6	2.2	24	-2	17	0	5	4	29	-17	45	129	4	38	6	14	63	-20	-28
-377.35	13.7	-543.8	-1.9	19	10	10	-9	5	-9	25	-30	33	109	3	36	6	10	55	-20	-18
-0.16	4.6	-70.6	-25.4	-4	-14	5	-12	2	1	8	-8	8	32	-5	9	-1	8	10	9	-2
-186.72	11.1	-304.5	3.2	18	16	6	-4	6	-6	20	-12	21	88	4	21	7	11	40	-14	-13
-561.93	13.3	-707.3	-10.5	19	-9	21	-16	7	-17	36	-39	49	126	5	33	4	8	65	-16	-30

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
11	-4	-5	5	-1	-17	30	-297	-222	-254	349	-222	-215	-240	-209	-295	-173	-330	-62	-300	-49
41	-7	15	17	15	-28	52	-706	-874	-570	-118	-528	-858	-618	-753	-891	-419	-1267	-243	-939	-248
41	-3	25	10	15	-36	39	-567	-522	-481	-876	-427	-533	-489	-468	-632	-300	-712	-140	-674	-162
8	12	18	-1	30	-19	17	-37	-82	-40	-529	-26	-21	-41	-39	-12	-16	-29	-25	-19	-41
19	-1	18	3	26	-23	12	-364	-243	-300	-653	-270	-245	-307	-217	-355	-126	-388	-65	-356	-86
30	-2	12	14	9	-21	25	-735	-859	-589	-136	-550	-876	-632	-782	-928	-387	-1014	-222	-949	-252

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-298	-85	-401	-82	-359	-125	-401	-227	-416	20	-114	-95	-206	-75	-155	10	-204	-56	-128	0	-231
-959	-407	-1263	-144	-1149	-196	-1191	-293	-1185	12	-200	-391	-561	-426	-596	-6	-523	-102	-374	51	-741
-691	-264	-916	-137	-816	-182	-837	-289	-860	11	-180	-250	-416	-267	-420	0	-401	-79	-268	54	-518
-52	-72	-83	-61	-65	-72	-48	-104	-80	-27	-37	-72	-7	-35	-5	-9	-52	-58	-17	39	-7
-367	-100	-491	-119	-443	-155	-482	-238	-485	12	-135	-132	-230	-80	-198	13	-229	-86	-138	39	-256
-976	-382	-1290	-145	-1201	-186	-1227	-276	-1228	23	-227	-412	-561	-397	-628	1	-524	-118	-390	54	-744

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-57	-191	-151	-180	-76	34	-65	51	22	-11	-178	19	-204	-4	22	-52	-187	-20	-233	-85	28
-88	-509	-347	-383	-346	86	-559	107	-295	-22	-877	4	-895	-22	-207	-252	-358	-192	-349	-217	-71
-55	-393	-236	-310	-203	73	-342	64	-167	-57	-520	-9	-521	37	-61	-166	-361	-88	-368	-148	-55
-21	-16	-12	-35	7	-35	-78	-61	-60	-53	-106	-41	-14	0	28	-29	-73	-33	-103	-72	-38
-51	-207	-125	-207	-111	11	-172	-1	-184	-69	-351	-41	-329	-31	-117	-148	-307	-92	-296	-124	-67
-65	-506	-321	-381	-364	57	-668	33	-395	-62	-847	-21	-828	-61	-204	-301	-456	-197	-415	-276	-169

S1	S2	S7	S8	S9	S10	S15	S16
1	-116	-43	-33	36	32	64	-18
13	-509	-76	-93	15	57	10	-84
1	-319	-59	-109	2	41	29	-45
-38	-47	-12	-77	-8	-2	-6	17
-42	-179	-54	-72	22	-15	23	-52
-21	-523	-87	-105	-3	-16	-23	-160

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT F1Y UNDER ACTION τ_2

ELEMENT STRESS τ_2 lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-183.74	2.8	-236.5	44.5	6	60	-2	4	5	-1	12	-40	3	12	11	-2	10	-1	9	2	-16
-556.79	12.5	-704.8	-10.8	12	85	8	22	-13	25	-18	39	52	47	29	-4	9	2	-27	0	6
-373.72	6.1	-492.1	-26.5	1	56	9	3	-9	17	-21	36	39	42	27	-7	11	-7	-31	-4	2
0.08	-2.8	-13.9	-37.1	-3	-41	11	-21	0	-12	2	13	17	12	12	-9	14	-5	0	-14	-1
-186.02	1.2	-246.7	-76.3	5	14	10	-9	-13	7	-16	22	26	29	12	-16	13	9	-33	6	-2
-559.50	13.1	-719.1	--7.0	8	73	7	20	-10	28	-14	48	41	62	25	0	.5	20	-52	16	8

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-37	5	-20	10	-7	28	14	-35	-435	-69	-413	-7	-336	-79	-441	-102	-272	-88	-372	-117	-315
-60	30	-26	25	-5	62	-1	-375	-1038	-367	-950	-277	-865	-393	-1233	-195	-820	-196	-1117	-281	-1049
-70	22	-31	18	-8	49	2	-342	-702	-335	-601	-268	-508	-355	-809	-204	-483	-207	-712	-260	-649
-38	-6	-18	5	-4	15	4	-43	-42	-46	-23	-39	5	-60	-39	38	9	9	-33	11	-22
-55	11	-24	0	-6	23	15	-179	-371	-184	-320	-120	-289	-204	-424	-94	-222	-84	-374	-96	-353
-56	19	-15	8	4	45	20	-300	-1155	-280	-1057	-196	-1003	-317	-1363	-124	-906	-117	-1270	-182	-1191

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-167	-295	-169	-407	-214	-148	-217	-113	-260	-127	-168	-69	-132	0	-142	39	-163	-132	-41	-107	-5
-373	-945	-421	-1168	-506	-732	-398	-636	-431	-769	-271	-611	-151	-524	-80	-423	-185	-588	-178	-149	-209
-321	-561	-329	-805	-400	-472	-311	-392	-301	-513	-233	-420	-129	-302	-88	-276	-160	-458	-141	-58	-180
19	-16	-20	-78	-28	-19	-10	0	8	-56	-33	-93	60	-2	12	-50	-17	-144	0	58	-9
-131	-314	-216	-358	-220	-212	-122	-191	-120	-331	-154	-239	-24	-120	-26	-108	-462	-448	-23	-47	-73
-254	-1114	-432	-1152	-467	-786	-319	-765	-318	-929	-258	-670	-87	-581	-45	-452	-250	-517	-102	-255	-135

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-314	50	-404	77	-302	-28	70	-60	-172	-36	-105	65	3	-207	-326	-113	-148	55	-20	-97	-53
-513	-224	-696	-196	-519	74	43	-152	-521	-52	-337	99	-104	-338	-837	-63	-272	157	-515	-93	-754
-306	-197	-434	-173	-330	18	35	-134	-230	-63	-236	61	-58	-237	-617	-52	-239	163	-321	-34	-586
16	-2	25	-48	-19	-19	0	-68	-33	-54	-128	7	-134	-29	-97	-49	-94	11	-77	-12	-244
-209	-81	-238	-101	-201	17	-5	-102	-147	-74	-222	18	-111	-221	-236	-89	-168	127	-136	-27	-452
-604	-145	-753	-178	-578	7	24	-150	-598	-106	-465	63	-197	-420	-785	-169	-333	159	-531	-89	-949

S1	S2	S7	S8	S9	S10	S15	S16
-83	80	-124	-169	74	-68	114	-8
59	-186	-109	-466	-28	-266	71	22
26	-119	-102	-311	-14	-229	49	33
-6	-41	-18	-114	-16	-73	0	13
-40	-63	-130	-165	15	-210	30	46
28	-246	-195	-375	14	-419	35	8

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT G2Y UNDER ACTION T_2

STRESS T_2 lb/in	MEAN VALUES e_x	e_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-187.49	5.2	-270.0	-0.0	17	-8	7	18	12	21	-21	-10	-24	26	12	9	8	10	-23	12	22
-556.29	18.1	-786.9	-21.6	79	-33	19	33	15	58	-57	-1	-25	69	31	19	20	9	-59	20	53
-374.15	13.5	-554.6	-17.3	72	-29	21	24	17	43	-62	1	-24	52	28	12	13	14	-54	15	42
0.68	4.2	-28.4	-16.4	30	8	8	1	0	2	-17	0	-7	4	6	7	-1	7	-23	10	15
-186.94	10.9	-288.6	-11.3	43	2	13	16	16	24	-31	-1	-28	33	19	17	7	14	-34	21	29
-557.72	18.2	-800.1	-24.8	87	-24	19	33	16	52	-58	-1	-23	61	30	14	22	14	-49	18	47

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-7	-5	15	13	7	-10	21	8	-360	19	-506	43	-552	45	-647	63	-432	49	-507	38	-627
-5	-6	49	22	39	19	63	165	-1305	165	-1609	263	-1687	173	-1978	457	-1652	485	-1835	468	-2065
-9	-3	35	15	29	16	51	93	-840	94	-1090	162	-1145	102	-1374	242	-1038	255	-1185	253	-1374
8	0	9	2	6	12	6	-5	-61	9	-60	38	-60	27	-102	13	-39	19	-33	34	-56
-4	0	20	17	19	19	21	20	-425	27	-550	72	-608	27	-668	74	-470	68	-525	54	-653
-9	-7	45	24	33	28	62	164	-1288	166	-1619	270	-1704	127	-1991	444	-1633	467	-1846	449	-2073

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
112	-583	-148	-541	-120	-376	-101	-473	-14	-405	60	-256	21	-293	28	-310	-82	-126	-1	-108	40
547	-2052	-93	-1859	-92	-1326	-46	-1507	215	-1428	147	-854	276	-1011	277	-1234	-92	-541	39	-414	326
310	-1369	-88	-1280	-121	-866	-92	-1077	120	-971	107	-582	147	-657	139	-834	-86	-354	22	-259	188
-8	-109	1	-90	-44	-19	-31	-64	17	-71	39	-75	36	-66	4	-53	5	-14	-18	-12	22
89	-663	-108	-589	-153	-377	-130	-482	2	-439	73	-299	60	-342	42	-372	-52	-167	-20	-104	37
525	-2083	-130	-1844	-143	-1327	-82	-1501	193	-1434	149	-878	294	-1046	282	-1263	-91	-552	11	-411	291

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-490	12	-217	0	-171	39	-1	20	-276	72	-195	20	-515	-150	-91	-133	-109	-56	-197	-55	-107
-1507	161	-819	-12	-572	147	-291	31	-763	146	-703	27	-1455	-140	-560	-297	-344	-116	-621	-24	-458
-1066	67	-510	8	-374	125	-105	16	-461	117	-450	14	-977	-66	-316	-178	-139	-69	-382	28	-299
-10	9	27	-12	-8	8	-56	-41	31	-28	-111	-46	-23	24	-70	-3	-33	-47	-67	0	-67
-467	-2	-209	-4	-172	71	-45	0	-276	44	-302	-52	-475	-26	-101	-104	-61	-69	-198	-37	-114
-1454	121	-808	-30	-570	226	-345	39	-813	154	-803	0	-1436	-109	-606	-290	-359	-122	-594	0	-456

S1	S2	S7	S8	S9	S10	S15	S16
59	-240	-130	-63	6	-165	45	-105
159	-725	-99	-406	74	-513	109	-187
127	-516	-68	-252	57	-309	105	-80
-4	-109	26	52	22	-37	12	-11
37	-259	-7	-95	17	-161	55	-15
176	-750	-76	-410	64	-494	93	-180

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT HGY UNDER ACTION τ_{2}

ELEMENT STRESS τ_{2} lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-185.10	6.9	-223.5	-18.3	12	15	13	6	7	11	5	17	8	0	7	4	-4	28	-17	10	23
-556.08	23.0	-713.5	-75.3	23	34	35	3	33	20	42	31	18	2	29	33	7	67	-30	36	45
-374.16	15.4	-481.7	-52.9	25	27	27	0	24	12	21	28	17	2	18	23	4	46	-23	12	46
-0.12	3.3	-2.6	0.0	2	3	6	7	-2	0	1	12	2	-2	3	-2	2	15	2	-13	4
-185.84	9.0	-231.8	-31.6	17	21	19	1	8	7	5	22	16	0	10	7	2	38	-12	-6	30
-557.57	21.1	-720.4	-72.1	26	31	40	0	35	16	37	35	19	-4	26	28	10	56	-31	17	53

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-5	6	0	-1	0	-2	15	-44	-397	-79	-450	-97	-370	-120	-333	-102	-302	-95	-259	-112	-302
-1	30	19	5	27	4	31	-69	-1312	-159	-1497	-169	-1233	-313	-1174	-175	-1049	-189	-944	-184	-1102
-8	20	8	4	10	0	17	-54	-885	-126	-1010	-131	-817	-231	-781	-142	-689	-153	-594	-162	-716
11	-2	5	1	7	0	10	8	-51	15	-32	9	-43	1	-41	14	2	7	-1	-1	-19
-12	9	5	1	10	0	12	-26	-415	-71	-472	-90	-411	-118	+375	-83	-317	-88	-283	-94	-338
-9	34	10	8	29	10	22	-67	-1339	-149	-1530	-167	-1262	-312	-1204	-165	-1076	-178	-981	-181	-1136

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-96	-264	-226	-232	-151	-190	-191	-250	-116	-234	-24	-122	-82	-167	-95	-161	-164	-62	-83	-101	-57
-134	-969	-538	-875	-410	-828	-488	-930	-280	-882	-79	-564	-130	-699	-199	-647	-299	-308	-167	-337	-91
-120	-632	-404	-567	-293	-523	-360	-609	-205	-559	-63	-344	-111	-445	-157	-417	-249	-184	-126	-206	-83
5	-20	1	-11	-3	-6	-13	-13	2	5	6	-22	13	5	-1	-10	0	-9	-5	3	-6
-78	-299	-229	-255	-154	-215	-199	-281	-114	-260	-16	-158	-64	-198	-88	-191	-157	-93	-79	-108	-44
-120	-1009	-543	-902	-398	-853	-485	-937	-272	-909	-72	-583	-116	-721	-173	-666	-282	-326	-169	-341	-90

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-172	-21	-215	37	-113	-29	-367	-34	-260	-32	-204	24	-48	-131	-92	-101	-12	-148	-127	-11	-16
-559	-81	-715	30	-411	-44	-988	-41	-716	-38	-609	78	-223	-272	-381	-279	-165	-377	-449	-55	-81
-361	-52	-481	44	-279	-29	-647	-49	-461	-60	-396	20	-163	-263	-222	-218	-91	-270	-306	-43	-62
6	4	-6	7	-10	-21	-91	-35	-15	-23	-63	9	-37	-26	-15	8	-7	-26	-50	7	-32
-167	-16	-218	41	-130	-37	-359	-38	-246	-22	-258	21	-114	-165	-92	-134	-55	-154	-177	-76	-119
-566	-63	-721	21	-438	-68	-1005	-74	-757	-69	-669	39	-290	-312	-429	-310	-228	-403	-503	-88	-193

S1	S2	S7	S8	S9	S10	S15	S16
60	-18	-228	-74	-58	-40	39	-106
128	-168	-411	-255	-103	-117	21	-244
82	-86	-345	-155	-67	-76	38	-184
3	5	1	-10	-2	-3	-3	-14
61	-20	-224	-102	-61	-58	10	-128
115	-176	-407	-262	-111	-131	26	-264

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT I5Y UNDER ACTION T_z

STRESS T_z lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-185.29	7.9	-332.0	30.4	-6	11	0	28	-4	2	22	19	16	16	9	20	18	16	5	-7	8
-558.62	15.9	-949.3	24.3	-6	9	-1	47	-1	6	8	64	48	12	47	21	38	21	-9	-2	29
-375.42	13.7	-682.6	3.1	-8	2	-2	32	-5	10	27	59	50	15	29	18	31	14	-4	-5	25
-0.32	1.0	-64.1	-63.3	3	-44	-5	-13	11	1	20	28	25	-5	2	-1	11	3	21	-16	2
-186.55	5.9	-374.4	-19.9	-1	-13	-3	26	-2	8	24	29	24	17	7	17	17	7	6	-11	7
-558.10	14.4	-955.7	2.5	-9	-14	-5	38	0	6	27	65	53	12	45	19	46	22	-8	-11	30

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
5	6	-11	20	-6	7	-7	-274	-277	-232	-260	-310	-320	-381	-254	-263	-217	-285	-101	-335	-157
-8	29	-21	55	-22	32	-16	-726	-1025	-629	-948	-845	-1152	-1005	-849	-848	-603	-986	-278	-1126	-431
2	24	-10	39	-14	17	-20	-539	-692	-448	-633	-638	-790	-780	-559	-529	-437	-655	-163	-782	-323
-1	10	5	0	-11	-4	-17	-40	-90	-56	-12	-49	-93	-74	-107	-11	-46	-40	-26	-26	-33
-5	9	-5	11	-15	-6	-7	-324	-350	-269	-292	-388	-380	-454	-314	-293	-213	-348	-102	-390	-161
-18	26	-19	55	-26	33	-23	-784	-1021	-669	-894	-895	-1146	-1047	-831	-910	-535	-1077	-200	-1250	-329

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-412	-180	-469	-359	-530	-221	-569	-83	-584	-145	-214	-16	-319	49	-418	33	-197	-104	-132	-106	-286
-1362	-396	-1299	-636	-1484	-448	-1627	-155	-1707	-212	-428	-347	-777	-169	-1056	-110	-373	-321	-547	-5	-1038
-989	-297	-930	-565	-1072	-377	-1164	-130	-1229	-203	-362	-165	-588	-90	-792	-58	-291	-273	-357	-34	-700
-62	-61	-75	-74	-81	-63	-116	-41	-153	-104	-65	-96	-29	-83	-141	-36	-30	-46	-32	23	11
-505	-158	-531	-402	-606	-223	-687	-86	-759	-110	-257	-64	-327	3	-502	14	-215	-209	-209	-62	-305
-1452	-322	-1346	-619	-1573	-379	-1738	-96	-1874	-56	-465	-363	-822	-151	-1119	-53	-375	-353	-616	78	-1106

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-200	-129	-349	-33	-155	-121	-65	-43	78	-27	-390	46	-320	-29	-284	58	-82	130	-45	22	-123
-204	-515	-774	-146	-501	-101	-616	30	-8	-62	-1397	202	-1193	7	-467	169	-413	311	-361	96	-290
-188	-316	-595	-87	-338	-80	-332	-42	15	-110	-907	143	-759	0	-445	155	-305	214	-270	111	-247
25	9	-23	-17	-38	18	-28	-83	-92	-52	-199	-16	-248	-26	-129	-37	-71	25	-43	5	-81
-131	-126	-324	-48	-175	-163	-172	-143	-75	-127	-534	19	-485	-30	-413	53	-249	137	-132	-17	-143
-108	-542	-714	-158	-516	-142	-626	-76	-112	-146	-1491	152	-1302	2	-496	150	-479	297	-341	76	-241

S1	S2	S7	S8	S9	S10	S15	S16
-82	-20	3	-146	45	-100	90	-117
-87	-398	187	-304	-44	-46	152	-410
-81	-213	102	-238	2	-96	145	-262
-7	-92	17	-16	-2	-41	64	-3
-57	-98	7	-187	-24	-64	84	-129
-104	-466	175	-317	-112	-34	137	-415

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT J1Y UNDER ACTION τ_z

STRESS	MEAN VALUES			INDIVIDUAL VALUES OF STRAIN																
τ_z lb/in	e_x	e_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-184.96	10.5	-306.3	-58.2	14	30	-4	17	8	-2	49	-11	6	6	17	4	18	10	70	-20	21
-556.71	23.3	-973.6	-160.6	42	30	-7	17	16	24	87	-13	31	18	40	-1	31	15	141	-23	63
-373.49	14.2	-684.9	-111.5	53	25	-1	16	19	2	67	-19	25	11	34	-8	28	-1	125	-27	55
0.24	-7.1	-32.2	-21.4	6	-26	-14	3	-2	-12	4	-1	0	-18	3	-7	-1	-8	14	-1	-12
-185.55	5.0	-344.9	-61.6	22	13	-4	12	5	-16	47	-12	10	-1	20	-3	11	-3	81	-26	5
-558.56	13.8	-990.4	-161.6	43	12	-9	10	24	9	103	-34	29	-13	36	-25	36	-8	150	-46	55

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
5	-7	-8	4	8	0	13	-124	-427	-183	-374	-224	-479	-207	-467	-329	-253	-338	-252	-324	-205
20	-20	-18	25	6	3	28	-400	-1485	-479	-1399	-526	-1699	-410	-1678	-843	-999	-838	-1019	-752	-838
-2	-57	-19	12	-2	-3	7	-304	-1024	-399	-939	-454	-1146	-357	-1099	-607	-668	-619	-647	-562	-516
-43	-12	-14	-1	-13	-13	2	-20	-100	0	-86	-63	-118	-37	-93	21	-16	3	-26	-22	-8
-12	-13	-7	0	-13	-6	12	-173	-494	-223	-445	-283	-572	-217	-539	-331	-293	-348	-282	-340	-218
-2	-22	-28	17	-7	5	-3	-429	-1519	-496	-1451	-535	-1768	-414	-1727	-861	-1022	-879	-997	-789	-841

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-238	-302	-288	-275	-269	-261	-366	-270	-444	-109	-167	-167	-334	-44	-286	-44	-245	-106	-49	-137	-49
-525	-1180	-835	-840	-827	-821	-998	-977	-1175	-610	-271	-914	-616	-504	-563	-469	-475	-453	-255	-207	-272
-401	-761	-591	-620	-569	-607	-704	-692	-859	-396	-252	-552	-488	-287	-430	-259	-369	-334	-161	-170	-176
-26	-12	-54	-92	-45	-39	-7	-60	-43	-9	-64	-75	10	-23	3	-27	-39	-29	-13	-24	17
-261	-317	-352	-342	-329	-302	-407	-307	-503	-179	-203	-225	-321	-82	-276	-62	-279	-155	-73	-156	-46
-578	-1174	-868	-840	-884	-808	-1044	-929	-1228	-569	-276	-940	-631	-525	-595	-459	-504	-460	-285	-207	-287

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-316	12	-195	54	-243	-20	-183	-353	-233	10	-624	42	-567	-42	-337	-101	-143	-192	-110	-155	-39
-794	-194	-540	-79	-680	27	-877	-231	-877	46	-2050	156	-2016	-2	-775	-220	-417	-454	-450	-434	-306
-581	-121	-369	-38	-472	10	-436	-186	-503	9	-1376	105	-1368	20	-598	-156	-300	-313	-357	-314	-252
15	-1	-17	-23	-31	-80	-15	0	-186	-96	-253	-50	-164	-54	-117	-80	-48	-51	-158	-117	-88
-317	-1	-229	22	-307	-90	-265	-148	-288	-81	-883	-32	-712	-79	-456	-176	-189	-283	-220	-237	-203
-762	-216	-562	-97	-697	-43	-864	-288	-896	-32	-2110	104	-2075	-28	-808	-276	-430	-518	-489	-493	-429

S1	S2	S7	S8	S9	S10	S15	S16
-45	-186	-88	-95	22	-138	113	-158
27	-918	-9	-281	-129	-215	123	-554
-3	-589	4	-203	-39	-174	132	-327
-66	-88	-27	-56	10	-51	-14	-146
-88	-293	-119	-160	-20	-198	79	-257
-13	-1037	-37	-279	-157	-237	89	-527

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT K2Y UNDER ACTION T_L

STRESS T_L lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-185.22	11.7	-323.7	50.1	22	-6	14	27	26	29	35	22	-15	-27	0	37	9	7	49	-49	-11
-556.16	25.9	-968.0	86.7	62	-5	31	44	53	77	73	-28	58	-36	1	58	-11	36	79	-52	-15
-374.04	21.5	-651.0	86.1	63	-26	26	37	41	60	64	-10	48	-31	3	49	-4	26	66	-45	-12
0.04	4.5	-25.0	52.8	21	-18	-3	3	14	8	25	2	6	-7	-6	10	10	3	22	-14	0
-186.00	16.2	-345.8	91.7	42	-6	16	19	37	30	53	15	10	-30	6	34	18	12	55	-18	-3
-556.98	27.3	-969.2	110.7	75	-14	32	30	64	66	83	-25	64	-25	6	50	-9	32	96	-30	-14

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
11	-11	-11	37	14	42	28	-180	-394	-107	-534	-198	-400	-187	-234	-134	-477	-185	-380	-224	-443
3	-40	-3	95	61	44	32	-244	-1663	-103	-1816	-275	-1467	-394	-546	-230	-1797	-348	-539	-396	-1526
11	-17	-4	66	35	42	26	-195	-1122	-67	-1298	-195	-1011	-263	-601	-179	-1206	-273	17	-325	-1019
2	11	1	-10	4	6	13	-14	-56	19	-93	13	-52	-14	20	-6	-35	-29	-16	-20	-39
-4	1	-9	31	15	36	22	-200	-479	-126	-605	-202	-409	-221	-201	-166	-492	-227	-362	-264	-417
-3	-34	-7	114	48	53	4	-304	-1661	-166	-1817	-327	-1445	-472	-903	-316	-1749	-448	-410	-523	-1406

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-122	-408	-282	-268	-282	-236	-249	-441	-188	-404	-44	16	-218	8	-244	-127	-139	-119	-8	-323	-50
-130	-1673	-750	-870	-798	-878	-639	-1344	-596	-1276	-81	-546	-316	-471	-399	-779	-232	-444	-97	-776	-248
-110	-1124	-513	-565	-547	-563	-441	-951	-431	-917	-35	-294	-252	-228	-359	-477	-184	-300	-53	-619	-179
4	-95	-15	13	-16	68	-19	-57	-76	-55	18	60	28	68	-42	12	-7	-7	-47	-134	-9
-160	-429	-286	-255	-303	-221	-296	-408	-327	-362	-58	42	-188	25	-251	-120	-128	-137	-104	-335	-118
-248	-1510	-807	-800	-896	-772	-793	-1156	-825	-1077	-125	-480	-368	-416	-462	-711	-213	-466	-240	-666	-376

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-442	20	-273	71	-250	-85	-257	-36	-133	-28	-7	25	-114	-38	-100	-30	-40	51	-81	102	52
-1071	-118	-713	128	-997	-44	-751	106	-346	19	-78	31	-252	30	-249	1	-68	155	-276	192	81
-810	-23	-516	126	-690	-43	-517	59	-253	22	-75	48	-181	23	-167	22	9	132	-159	182	25
-81	54	-45	26	-55	-27	28	-27	-14	-38	-88	-23	-177	-19	28	-10	61	-30	124	-14	-32
-441	15	-283	74	-313	-107	-244	-34	-123	-11	-64	-18	-164	-35	-74	-6	30	70	5	108	-25
-1005	-170	-703	105	-1013	-94	-839	88	-384	2	-158	-26	-314	-33	-275	-42	-40	157	-195	127	-18

S1	S2	S7	S8	S9	S10	S15	S16
18	69	-93	-18	1	-21	36	-145
-33	26	-51	-245	101	4	124	-338
-23	59	-45	-157	40	12	95	-242
4	11	44	-17	-121	-37	7	-18
-67	61	-55	-109	-89	-70	67	-117
-133	34	8	-230	-27	-13	91	-362

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT LGY UNDER ACTION T_x

STRESS T_x lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-184.85	16.6	-331.9	6.3	8	11	7	36	6	25	15	-10	2	34	38	21	35	16	0	10	30
-556.28	50.8	-1047.5	44.3	17	29	11	133	28	74	28	-11	-13	63	100	56	108	47	19	21	60
-373.42	37.0	-712.1	25.1	11	25	15	96	16	53	24	-8	-5	66	72	41	74	44	0	16	52
-0.23	-0.0	-128	-2.2	-6	4	-2	11	-3	-4	1	7	7	11	0	-3	-8	0	-11	-6	6
-185.05	17.4	-349	6.6	0	20	1	50	1	29	3	-5	0	28	39	27	30	27	-11	12	31
-557.49	50.9	-1059.1	35.8	17	28	8	132	28	76	23	0	-8	65	102	57	114	55	14	13	55

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
46	5	23	15	25	-13	5	-135	-482	-109	-451	-212	-286	-219	-333	-333	-322	-393	-365	-375	-378
124	27	93	50	96	14	35	-266	-1718	-168	-1563	-396	-1218	-508	-1308	-979	-1108	-1083	-1237	-1068	-1220
91	17	63	30	73	-2	17	-205	-1098	-163	-1007	-350	-738	-410	-794	-674	-735	-753	-833	-758	-836
7	0	0	-1	4	-4	-8	6	-30	0	-522	-23	-525	-517	-516	-505	-18	-10	-27	-22	-31
45	0	30	10	37	-14	21	-134	-495	-109	-466	-233	-327	-247	-343	-335	-336	-390	-389	-399	-402
125	16	96	53	94	7	41	-259	-1736	-182	-1575	-394	-1236	-526	-1335	-1022	-1068	-1115	-1204	-1120	-1195

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-313	-290	-327	-208	-357	-242	-394	-268	-354	-222	-96	-137	-127	-187	-273	-179	-95	-70	-154	-94	-264
-887	-1070	-1026	-660	-1084	-806	-1216	-850	-1131	-811	-161	-603	-324	-679	-785	-608	-263	-263	-466	-388	-813
-615	-716	-690	-447	-735	-544	-827	-579	-746	-531	-136	-347	-246	-452	-560	-420	-162	-168	-292	-255	-580
3	-63	-4	-13	-27	3	-24	1	-18	19	4	-7	10	-32	-19	-17	7	-2	-3	9	-21
-324	-328	-333	-222	-379	-263	-420	-262	-382	-216	-96	-136	-141	-215	-306	-183	-90	-77	-159	-99	-290
-932	-1049	-1072	-620	-1143	-762	-1281	-807	-1216	-747	-153	-612	-342	-693	-822	-556	-284	-246	-504	-339	-852

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-120	-146	-198	-45	-210	-65	-256	-27	-387	-156	-142	-134	-326	-121	9	-79	-23	-93	-85	-130	-9
-426	-410	-673	-108	-750	-132	-1157	-53	-1317	-312	-733	-317	-1394	-402	79	-246	-111	-365	-165	-442	-10
-272	-306	-457	-65	-462	-105	-663	-44	-829	-250	-370	-224	-841	-248	49	-124	-39	-208	-75	-272	60
-1	0	-10	-4	4	-18	-43	-17	-50	-16	-40	-13	-31	-20	-19	-18	-578	11	46	-16	-6
-123	-148	-211	-49	-215	-94	-262	-67	-397	-194	-169	-152	-348	-103	43	-62	35	-73	-14	-159	35
-400	-424	-672	-81	-761	-135	-1159	-60	-1349	-303	-775	-308	-1412	-378	130	-244	-44	-367	-98	-466	18

S1	S2	S7	S8	S9	S10	S15	S16
-87	-138	-13	8	-68	-14	-91	-197
-190	-709	-84	71	-267	-5	-141	-628
-120	-403	-42	17	-158	4	-109	-373
29	-2	22	-10	26	25	-7	-5
-131	-144	-31	-6	-87	22	-56	-194
-212	-702	-74	42	-321	36	-141	-664

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT A5X UNDER ACTION τ_1

STRESS — MEAN VALUES — INDIVIDUAL VALUES OF STRAIN

τ_1 lb/in	ϵ_x	ϵ_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-366.40	-115.1	26.7	-48.9	-82	-94	-219	-218	-132	-42	-144	-67	-69	-96	-187	-184	-101	-79	-113	-106	-21
-1094.93	-375.4	43.7	-83.0	-398	-358	-513	-476	-391	-255	-503	-351	-317	-358	-444	-449	-310	-309	-400	-401	-140
-732.48	-245.0	23.3	-65.4	-242	-199	-391	-353	-269	-140	-354	-173	-189	-206	-344	-322	-213	-178	-270	-247	-66
0.70	-2.0	20.1	23.6	-10	5	-28	-4	-5	14	-7	10	-6	5	-19	5	0	13	4	5	5
-365.81	-111.5	36.0	-35.0	-95	-62	-231	-202	-132	-31	-155	-46	-73	-75	-198	-184	-109	-59	-111	-78	-23
-1094.74	-372.4	47.2	-98.0	-390	-359	-507	-485	-381	-263	-498	-353	-325	-345	-439	-446	-312	-308	-394	-394	-147

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-82	-212	-135	-76	-77	-105	-112	105	-1	48	42	-15	146	42	116	-44	181	-24	176	38	-89
-372	-495	-420	-270	-268	-392	-407	474	136	139	123	-7	349	210	363	-300	178	-152	370	27	-203
-207	-387	-276	-191	-161	-255	-238	314	58	105	99	-4	287	154	267	-203	224	-101	337	41	-164
2	-28	0	-2	3	-11	-1	9	-3	12	-32	-4	28	37	26	-16	70	3	161	21	-4
-67	-228	-143	-93	-61	-111	-97	79	-21	34	13	-13	163	80	138	-72	237	-24	285	52	-69
-349	-497	-407	-278	-259	-390	-400	447	132	148	82	-5	317	235	330	-305	209	-148	401	25	-183

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-6	-139	-21	35	26	-71	48	31	35	103	122	119	-93	29	-77	-184	-158	-179	53	155	-25
-78	-390	8	142	56	-93	97	241	118	-316	196	-42	-146	377	-333	-602	-410	-381	23	643	-192
-49	-314	-1	82	35	-124	72	164	88	-516	219	-13	-92	342	-217	-463	-326	-297	42	506	-126
-14	-70	32	-15	29	-35	20	33	-5	71	220	159	-37	76	16	-17	-159	-112	153	131	1
-14	-181	27	9	39	-89	33	62	6	142	228	98	-117	166	-105	-185	-217	-207	86	208	-17
-71	-405	43	110	62	-103	87	256	93	-302	200	-74	-189	425	-371	-548	-440	-381	48	641	-158

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-92	-12	192	-77	-221	35	60	80	36	32	58	38	18	0	81	75	109	39	167	68	215
-413	-293	-38	-42	-338	97	156	200	112	170	216	117	-20	91	184	268	203	207	177	347	651
-327	-148	130	-94	-284	19	47	88	-17	83	97	68	-30	113	198	170	141	122	192	233	470
-154	94	175	-241	-172	-26	-147	-39	-124	-63	-48	-52	-19	21	40	-16	27	-30	71	-34	43
-164	31	218	-196	-218	-35	-61	28	-68	2	43	-19	-1	4	114	81	124	64	242	68	287
-463	-218	-34	-62	-322	54	14	151	4	123	54	20	-146	98	221	249	227	186	329	330	637

S1	S2	S7	S8	S9	S10	S15	S16
16	-39	-89	-100	3	30	90	-119
-60	-5	-283	-344	42	-118	302	-377
-41	-9	-217	-209	19	-24	236	-290
-41	-51	-8	-44	32	78	-7	-108
-21	-35	-102	-82	-22	68	93	-187
-111	-1	-325	-337	16	-40	250	-413

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT B1X UNDER ACTION τ.

STRESS τ, lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-371.26	-139.4	-0.5	9.2	-144	-109	-155	-115	-127	-96	-95	-60	-167	-165	-252	-128	-154	-141	-92	-119	-192
-1116.22	-469.5	30.1	136.0	-541	-320	-491	-318	-451	-306	-491	-334	-504	-447	-790	-330	-493	-438	-477	-513	-492
-748.22	-307.6	23.1	87.4	-355	-207	-345	-193	-304	-177	-311	-181	-333	-298	-568	-214	-339	-288	-298	-316	-308
-0.0	6.7	13.5	42.2	-9	0	-13	12	-8	25	26	18	11	9	-41	18	-8	30	26	10	70
-372.24	-132.5	12.0	57.8	-149	-102	-177	-79	-137	-67	-97	-44	-149	-145	-295	-100	-176	-118	-108	-96	-118
-1118.82	-469.1	32.7	150.9	-559	-315	-509	-302	-452	-312	-485	-331	-511	-448	-817	-313	-494	-429	-481	-497	-467

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-252	-95	-138	-151	-130	-104	-155	-27	-5	50	-33	8	-52	-53	3	53	39	44	37	60	-30
-795	-288	-438	-484	-453	-446	-620	-55	119	177	-67	45	52	116	92	39	-35	74	127	113	-56
-538	-195	-288	-347	-298	-269	-402	-38	49	181	-50	69	4	45	26	73	29	87	104	100	-45
-20	-6	-1	-12	-5	19	6	-18	-2	170	6	115	-73	-4	-24	-9	34	-26	27	13	-9
-255	-100	-123	-172	-113	-88	-160	-85	-20	160	-49	116	-88	-10	-29	60	64	53	57	86	-44
-811	-291	-405	-499	-441	-443	-635	-127	120	215	-76	77	29	141	86	26	-33	73	123	124	-61

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
105	45	54	-40	57	-119	33	-87	50	-156	86	-8	-161	-133	-79	-59	-13	-114	4	-35	-58
230	53	237	-21	140	-298	41	-65	2	-115	407	26	-304	-316	-352	-198	-124	-448	-110	-72	-347
228	67	177	-24	81	-237	8	-83	-25	-162	403	17	-237	-244	-290	-113	-38	-306	-72	-26	-191
114	-7	55	5	7	-62	-34	-17	-38	-11	400	25	-80	6	-112	42	12	-53	0	33	53
202	22	107	-99	60	-161	18	-87	17	-159	393	0	-202	-123	-156	21	-14	-158	-14	-22	-17
280	43	252	-72	131	-316	51	-72	-2	-114	458	44	-306	-310	-382	-144	-140	-468	-111	-97	-322

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-70	71	-74	-267	-143	50	-59	171	-81	92	-26	128	44	113	-78	74	-43	45	16	15	-184
-163	-106	-422	-731	-385	187	-11	468	-282	389	51	271	103	316	-94	261	-212	238	48	154	-134
-108	36	-239	-603	-281	125	-91	360	-220	277	48	204	70	205	-42	163	-184	173	7	89	-194
7	202	30	-311	-77	-63	-113	88	-94	-28	-17	-96	37	17	-88	-20	-51	25	-18	20	-20
-89	187	-91	-464	-184	-16	-135	199	-190	92	-46	46	46	60	-92	40	-128	57	-60	38	-259
-182	-57	-432	-757	-429	89	-76	474	-382	353	-10	244	85	239	-119	251	-217	243	29	133	-189

S1	S2	S7	S8	S9	S10	S15	S16
21	38	-69	-101	-5	-55	-49	-155
165	120	-314	-412	48	-30	-131	-430
109	81	-194	-238	16	-42	-42	-360
-11	23	-43	-4	18	23	63	-59
17	35	-106	-91	3	-76	-55	-220
143	82	-364	-437	37	-53	-163	-488

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT C2X UNDER ACTION τ_i

STRESS τ_i lb/in²	MEAN VALUES ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-371.07	-178.2	12.3	54.1	-146	-82	-199	-251	-116	-83	-266	-164	-137	-125	-180	-224	-131	-148	-220	-199	-380
-1119.93	-573.7	45.9	200.8	-526	-419	-553	-669	-417	-358	-807	-582	-440	-553	-526	-654	-423	-529	-702	-656	-1057
-748.90	-382.3	36.8	151.7	-360	-231	-383	-474	-265	-209	-567	-361	-296	-312	-370	-463	-275	-327	-496	-436	-746
-0.0	-2.7	11.2	26.0	8	17	0	-6	-1	8	-9	9	-7	0	10	-6	9	15	-17	-1	-74
-371.78	-183.4	19.7	80.8	-153	-65	-203	-255	-117	-80	-245	-198	-145	-135	-174	-233	-124	-150	-219	-220	-425
-1118.00	-571.8	50.2	196.9	-543	-408	-585	-647	-416	-359	-759	-620	-446	-534	-534	-639	-426	-522	-671	-673	-1064

INDIVIDUAL VALUES OF STRAIN

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-180	-174	-185	-136	-155	-166	-219	84	-23	16	4	46	-27	26	-8	-77	108	42	9	84	-35
-633	-470	-595	-437	-522	-551	-681	313	2	161	35	168	-23	50	119	-201	89	47	-69	197	-133
-394	-337	-398	-294	-339	-381	-451	223	-18	95	5	112	-33	40	39	-148	116	65	-35	187	-116
4	3	-16	1	4	-20	2	128	-24	0	-3	15	4	15	24	-38	-25	-3	19	10	-15
-173	-177	-189	-138	-164	-173	-235	187	-56	33	-6	61	-26	43	-16	-86	112	52	16	108	-40
-636	-473	-560	-438	-523	-529	-707	403	-9	165	33	155	-26	34	121	-218	83	32	-44	179	-112

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
153	-84	45	34	28	-9	24	-46	-20	26	-2	30	-42	-165	-64	-124	-50	-75	-223	-107	7
318	-237	153	120	99	75	47	18	-17	220	-13	87	-20	-354	-303	-406	-235	-283	-576	-191	-86
287	-152	121	107	71	47	45	-7	-19	99	24	112	-1	-281	-230	-265	-124	-131	-464	-144	25
-1	13	-4	-3	7	-4	32	2	0	23	105	84	-9	-69	-61	-1	39	30	-71	0	89
165	-71	47	25	33	3	35	-32	5	32	62	86	-51	-140	-129	-102	-24	-50	-220	-140	93
302	-221	127	127	92	97	36	50	-26	251	-61	120	-74	-294	-341	-373	-227	-284	-523	-223	-49

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-119	-104	20	-256	-138	75	111	62	-115	70	8	-80	0	51	94	16	98	85	87	65	163
-393	-485	-245	-626	-414	234	272	249	-141	328	221	-232	102	252	372	149	313	262	263	185	440
-258	-301	-105	-486	-298	172	194	151	-199	198	105	-193	-75	162	276	88	251	161	205	122	356
23	24	69	-103	-119	-2	-66	-32	-61	-39	-113	-51	-28	19	-8	-8	3	-11	27	-57	63
-138	-53	9	-303	-228	63	145	73	-134	99	-7	-74	-35	154	174	43	154	107	138	26	243
-436	-436	-281	-574	-480	203	259	227	-207	330	150	-223	152	180	405	144	371	222	281	152	546

S1	S2	S7	S8	S9	S10	S15	S16
-20	-37	-91	15	-64	-86	-194	45
-70	-82	-394	14	-29	-144	-369	76
-31	-66	-249	70	-40	-124	-225	90
9	26	-4	32	6	9	22	-43
6	4	-109	65	-27	-96	-125	-24
-70	-28	-404	23	15	-186	-327	28

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT DGX UNDER ACTION τ_1

STRESS τ_1 lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-371.23	-183.2	16.3	38.5	-154	-167	-217	-230	-212	-155	-106	-158	-213	-185	-225	-192	-178	-195	-145	-219	-196
-1104.82	-571.3	53.1	103.5	-575	-556	-553	-639	-599	-541	-396	-562	-643	-630	-606	-559	-501	-639	-480	-761	-524
-740.45	-383.4	36.0	73.8	-374	-387	-393	-438	-420	-359	-236	-357	-443	-407	-430	-373	-348	-417	-311	-490	-377
0.12	-1.7	10.1	8.0	-4	6	-3	2	-10	4	-3	4	-17	5	-7	0	-4	4	0	-4	-4
-369.50	-187.8	-4.5	41.6	-159	-178	-229	-239	-211	-165	-110	-141	-239	-192	-235	-202	-182	-191	-142	-223	-211
-1104.19	-572.4	56.1	115.4	-581	-560	-550	-642	-594	-545	-412	-543	-650	-631	-615	-563	-504	-636	-483	-754	-529

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-210	-124	-210	-157	-220	-146	-171	72	8	24	37	-23	18	-14	61	53	-6	31	16	78	40
-695	-335	-686	-456	-680	-479	-609	193	32	83	69	-27	67	21	182	107	-61	38	22	212	91
-453	-229	-464	-317	-456	-319	-393	145	7	62	36	-21	11	-3	98	103	-33	44	22	158	74
2	0	-7	-3	-3	0	3	32	-34	5	0	-6	7	-10	11	8	-4	11	12	12	21
-207	-120	-221	-153	-234	-139	-173	100	-32	34	8	-17	-4	-15	36	55	-3	35	28	92	47
-692	-341	-684	-453	-683	-478	-604	209	9	83	56	-21	65	26	169	95	-61	35	27	213	96

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
27	-45	14	48	42	-13	14	1	5	-27	-7	-106	-77	-75	-17	-138	-3	-71	-56	-72	-110
53	-114	-6	243	103	41	75	104	93	73	-56	-337	-193	-200	-61	-454	-137	-256	-173	-199	-398
39	-85	0	144	79	10	46	53	55	22	-15	-247	-122	-127	-23	-326	-47	-149	-105	-127	-268
-11	29	-1	5	4	0	-9	9	-3	3	0	5	10	36	12	-11	-10	8	-6	13	-10
15	-21	14	42	37	-21	6	15	6	-25	6	-131	-48	-71	11	-178	20	-90	-85	-42	-136
44	-101	1	236	108	28	83	94	95	60	-64	-326	-189	-175	-63	-447	-141	-244	-181	-201	-390

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-64	-122	-72	-157	-134	172	-63	101	107	180	112	16	20	53	180	42	-4	-31	39	-17	-7
-216	-388	-300	-424	-376	445	-313	258	246	610	353	185	63	202	660	184	53	122	163	119	150
-114	-271	-174	-308	-250	352	-273	190	149	411	186	111	-17	85	404	93	53	56	126	52	80
17	-4	0	-9	-15	-9	-95	3	-71	-8	-89	-10	-57	-98	-50	-18	-6	-42	-7	-26	22
-27	-135	-52	-184	-138	168	-155	96	43	164	-5	-7	-55	-13	155	-13	-47	-54	49	-43	2426
-226	-392	-309	-425	-404	450	-404	230	179	612	205	185	12	145	642	154	39	108	149	113	104

S1	S2	S7	S8	S9	S10	S15	S16
-15	-164	27	8	-127	-115	-80	11
41	-436	-42	14	-217	-102	-276	98
22	-371	7	37	-161	-88	-192	76
-11	-27	-7	-15	-20	23	4	-13
-8	-164	19	-8	-147	-69	-130	1
20	-442	-34	17	-221	-124	-259	51

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT E5X UNDER ACTION τ_1

STRESS τ_1 lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-368.67	-215.1	31.9	6.5	-122	-188	-276	-217	-257	-207	-143	-111	-428	-225	-254	-284	-240	-292	-95	-197	-172
-1110.41	-676.6	93.9	87.1	-466	-504	-846	-488	-876	-515	-739	-508	-1361	-639	-698	-671	-741	-747	-538	-714	-427
-743.93	-462.4	78.7	68.2	-313	-349	-579	-356	-625	-379	-459	-281	-979	-432	-482	-494	-532	-531	-335	-453	-295
-0.0	-12.2	29.0	102.0	-28	6	-14	-8	-28	15	-22	-1	-62	0	-14	-22	-28	3	2	12	-9
-369.60	-223.9	60.5	54.7	-139	-161	-305	-204	-315	-203	-145	-126	-455	-211	-277	-275	-285	-278	-106	-188	-177
-1111.82	-680.0	100.1	90.2	-473	-503	-859	-485	-886	-491	-714	-578	-1362	-644	-710	-668	-759	-735	-531	-727	-407

INDIVIDUAL VALUES OF STRAIN

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-186	-306	-206	-184	-217	-112	-232	-68	39	50	142	86	91	-51	43	132	113	145	15	45	-15
-707	-798	-755	-478	-697	-484	-830	-9	339	175	544	318	273	-160	52	224	-21	282	-125	33	13
-441	-616	-489	-338	-496	-279	-554	-71	203	132	380	215	223	-131	46	272	64	256	-47	43	3
-13	-25	0	-18	-10	9	-33	8	3	17	28	8	33	-2	5	99	8	105	-8	49	14
-204	-353	-210	-200	-219	-102	-227	-79	73	48	156	94	126	-67	47	259	105	222	4	85	29
-712	-803	-744	-502	-713	-475	-828	43	382	177	563	295	253	-155	70	261	-42	310	-143	46	38

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-20	-90	46	2	-36	-27	55	-30	120	-9	136	131	-239	-360	-34	-125	-51	-102	60	-99	-104
-17	-96	248	50	-121	8	146	87	124	219	53	56	-478	-604	-142	-433	-65	-404	-67	-183	-592
-32	-71	210	0	-113	-4	87	55	95	123	135	86	-371	-486	-51	-237	0	-289	-16	-140	-406
16	-2	94	-27	50	-20	-14	-15	-44	27	311	161	-115	-89	113	73	27	-68	20	30	-55
17	-48	97	-15	2	-41	68	-57	129	-11	241	158	-319	-331	39	-10	-38	-95	137	-151	-145
14	-82	230	25	-124	3	148	63	131	251	89	82	-559	-566	-118	-377	-113	-407	20	-280	-562

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-76	77	194	-475	-323	-10	-93	92	50	299	101	42	0	14	56	19	-72	62	-80	18	83
-229	-250	-130	-955	-347	51	-70	426	282	1198	267	211	-22	-52	319	117	-74	404	-208	190	292
-149	-93	85	-798	-299	-23	-193	248	108	815	145	109	-21	-30	170	31	-76	264	-213	115	113
-73	195	185	-435	-228	-134	-246	-18	-188	25	-91	-26	-35	-19	-22	-42	-90	0	-39	5	-66
-122	172	239	-604	-366	-109	-250	99	-64	349	36	34	-101	-16	78	16	-202	71	-122	-22	18
-282	-196	-159	-934	-376	-22	-149	383	142	1162	165	206	-95	-99	338	76	-125	381	-299	95	238

S1	S2	S7	S8	S9	S10	S15	S16
61	-41	-104	-44	-22	-76	-224	-195
129	-172	-699	-7	-77	-324	-384	-622
78	-109	-412	20	-45	-231	-301	-499
2	-2	-43	-42	0	-48	-60	-77
16	-104	-138	55	14	-178	-246	-331
82	-219	-741	33	-36	-398	-423	-715

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT F1X UNDER ACTION τ.

ELEMENT STRESS τ, lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-370.61	-254.9	9.7	-139.0	-331	-261	-320	-222	-192	-95	-218	-124	-184	-163	-258	-241	-196	-166	-1315	-252	-129
-1117.99	-703.5	49.8	-71.9	-1394	-875	-896	-612	-739	-398	-764	-391	-652	-494	-758	-674	-663	-553	-1137	-779	-499
-746.56	-469.1	39.9	-60.1	-963	-570	-650	-415	-485	-212	-519	-229	-427	-310	-533	-463	-446	-334	-781	-522	-310
0.08	-4.6	16.1	36.5	-61	-19	-29	-3	1	42	-28	28	0	10	-11	-4	3	45	-28	-17	-2
-370.77	-221.5	29.9	-19.8	-382	-314	-354	-216	-227	-55	-269	-76	-179	-154	-287	-252	-219	-119	-361	-233	-139
-1116.78	-707.2	62.3	-73.6	-1373	-943	-895	-622	-741	-398	-803	-357	-637	-501	-775	-688	-669	-536	-1158	-761	-487

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-186	-193	-211	-164	-227	-213	-247	92	-27	66	46	-15	72	78	63	60	-4	79	-30	12	-23
-657	-574	-699	-508	-685	-647	-825	84	70	164	135	-11	201	298	338	106	-175	120	-105	26	17
-429	-403	-466	-334	-457	-446	-542	81	19	146	97	-12	133	205	255	117	-100	103	-70	25	23
-5	-18	14	10	-7	-22	-8	-11	11	60	-7	35	-58	33	73	22	-33	12	10	13	32
-202	-223	-210	-160	-197	-218	-262	-11	-21	42	67	-13	70	89	217	86	-7	81	-1	34	22
-665	-610	-692	-511	-675	-649	-817	1	141	157	163	8	173	294	464	121	-181	109	-96	57	23

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-107	-65	18	32	5	23	36	-40	119	-65	1	112	-272	-275	-223	-177	-127	-649	-32	-108	28
-265	-55	79	230	19	208	-2	-28	341	-29	-206	76	-530	-454	-535	-435	-420	-563	-181	-114	-216
-190	-35	51	148	4	148	14	-46	249	-63	-78	114	-398	-379	-413	-315	-260	-338	-105	-95	-109
28	-44	-35	68	-7	27	18	-2	42	-19	288	78	-90	-152	-38	45	38	-1	24	14	31
-53	-68	0	141	5	67	29	-37	116	-87	182	94	-228	-297	-211	-174	-78	-169	-73	-63	-24
-215	-123	77	307	28	222	-14	-18	347	-44	-98	20	-472	-537	-507	-465	-368	-592	-257	-25	-256

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-58	56	41	-190	-273	-2	117	77	16	111	-6	188	195	86	54	53	-53	130	112	62	89
-158	-239	-325	-724	-500	-44	290	266	-7	380	-21	903	422	169	253	129	-37	427	218	290	265
-80	-78	-148	-571	-368	-86	187	164	-45	228	-32	624	307	120	168	99	-38	311	147	188	210
-9	138	154	-384	-86	-83	-183	-33	-168	-36	-93	3	-17	29	59	19	-6	25	-3	53	57
-13	51	104	-492	-205	-141	-37	16	7	45	-68	197	161	54	86	54	-32	146	86	59	127
-123	-255	-227	-861	-417	-88	143	246	40	359	-76	845	427	176	344	114	2	430	266	319	275

S1	S2	S7	S8	S9	S10	S15	S16
-21	17	-229	9	-4	-135	125	53
-101	-163	-642	53	46	-246	284	10
-94	-64	-446	48	14	-169	239	38
37	-6	15	-24	2	0	-4	-57
-29	1	-214	18	-45	-86	83	-38
-65	-178	-628	111	6	-197	220	-4

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT G2X UNDER ACTION τ_1

STRESS	MEAN VALUES			INDIVIDUAL VALUES OF STRAIN																
τ_1 lb/in²	ϵ_x	ϵ_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-365.97	-231.1	18.2	-34.8	-120	-186	-298	-234	-203	-340	-188	-169	-149	-245	-242	-233	-327	-300	-228	-204	-174
-1095.76	-736.3	59.4	-3.4	-533	-643	-719	-695	-600	-982	-880	-714	-535	-927	-599	-727	-910	-839	-825	-775	-532
-734.13	-499.2	45.9	-13.5	-338	-416	-508	-477	-412	-699	-562	-450	-346	-582	-431	-490	-669	-593	-566	-514	-348
0.23	-12.5	13.1	11.6	-5	1	-8	6	-6	-18	-22	12	6	1	-18	3	-25	-30	-42	-25	13
-366.98	-241.4	28.7	6.7	-112	-182	-256	-263	-212	-371	-220	-176	-131	-255	-227	-271	-361	-322	-233	-228	-158
-1097.44	-742.7	67.1	23.3	-527	-648	-687	-727	-613	-984	-934	-697	-521	-949	-579	-752	-929	-845	-836	-775	-531

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-206	-262	-250	-210	-332	-169	-265	46	-12	0	34	-12	31	-87	89	-12	16	-2	76	-8	64
-767	-714	-865	-513	-861	-499	-1008	196	-40	53	101	70	52	46	123	-52	37	-6	112	16	30
-481	-531	-581	-381	-616	-327	-655	151	-49	21	92	36	42	3	98	-38	27	11	98	11	54
-10	-28	-6	-18	-14	-23	-41	21	-34	-4	22	26	25	76	36	26	-3	26	-1	-20	2
-210	-269	-308	-230	-337	-162	-287	28	-29	-14	46	17	36	-69	117	-8	51	25	63	-14	67
-785	-697	-917	-519	-859	-492	-1010	166	-23	50	111	85	37	43	152	-69	73	-7	112	15	48

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-48	55	-4	114	0	22	74	29	88	-34	63	5	-318	-118	-202	-221	-48	-14	-27	-95	-55
-100	-30	156	243	77	-19	313	129	207	103	130	-157	-644	-379	-469	-661	-246	-292	-250	-207	-214
-95	0	111	197	79	-12	223	73	144	22	164	-95	-523	-236	-351	-463	-138	-158	-144	-127	-118
-43	-28	29	66	30	-13	22	15	-2	18	199	-17	-91	-5	-17	-2	-24	15	19	32	23
-83	71	42	129	39	10	125	31	102	-15	77	66	-385	-38	-264	-95	-62	48	22	-111	13
-113	-2	155	241	76	-17	324	131	210	143	77	-90	-673	-310	-550	-541	-281	-254	-243	-210	-162

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-94	12	-35	-125	-151	130	66	65	180	30	93	-14	70	-29	149	-139	-168	60	114	67	69
-448	-279	-378	-320	-479	363	157	250	639	210	291	176	135	13	528	-395	-533	202	396	325	329
-323	-122	-220	-252	-306	261	111	144	490	110	188	51	131	-53	344	-261	-383	104	262	168	189
-34	68	-5	-131	4	-60	12	-35	40	-31	11	-64	51	-22	94	-16	16	-24	41	25	47
-219	107	-153	-162	-175	112	83	20	218	19	143	-21	92	-48	173	-128	-147	57	160	74	97
-538	-189	-499	-309	-520	367	127	213	669	207	282	163	159	-23	508	-391	-525	207	365	327	292

S1	S2	S7	S8	S9	S10	S15	S16
0	-127	-105	-6	82	-82	-55	-30
16	-422	-382	-276	246	-203	-125	-89
2	-323	-270	-128	144	-122	-64	-44
-26	-28	-57	-29	-7	-1	-29	-38
-50	-51	-153	10	108	-79	-33	-55
-12	-341	-421	-244	250	-155	-99	-68

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT HGX UNDER ACTION τ_1

STRESS τ_1 lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-364.17	-237.1	17.0	-16.8	-174	-211	-288	-367	-199	-157	-229	-193	-218	-239	-294	-26C	-201	-154	-189	-309	-270
-1090.00	-744.8	57.3	-31.3	-610	-711	-793	-1032	-732	-500	-837	-632	-660	-779	-803	-763	-641	-510	-597	-1048	-738
-737.17	-504.5	38.7	-23.9	-382	-468	-566	-718	-485	-319	-540	-399	-451	-502	-577	-526	-435	-320	-401	-715	-517
77.04	-6.8	5.1	-0.4	-20	-29	-12	9	-15	3	1	24	-1	-3	-16	-12	-4	6	4	-41	-3
-365.37	-247.4	19.1	-11.1	-186	-229	-298	-395	-210	-153	-233	-177	-214	-243	-305	-297	-198	-157	-185	-334	-267
-1099.98	-749.6	56.4	-40.2	-623	-709	-795	-1035	-740	-507	-860	-619	-663	-786	-809	-766	-641	-520	-598	-1040	-737

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-302	-241	-259	-193	-329	-168	-232	-14	39	6	-22	47	-17	6	-39	82	25	32	14	1	62
-945	-664	-787	-572	-1191	-603	-715	-33	108	26	-59	168	-11	56	57	228	3	107	-88	-24	127
-623	-474	-562	-394	-844	-390	-491	-24	73	17	-59	119	-23	32	-4	182	33	81	-79	-7	107
-10	-18	18	-4	-17	-9	-8	16	-10	1	-8	-4	13	-9	13	6	2	2	-37	-3	15
-312	-247	-283	-186	-406	-175	-236	-29	37	3	-24	50	-10	0	-37	96	58	33	-16	-2	71
-948	-660	-809	-572	-1212	-604	-726	-46	115	28	-55	169	-16	36	66	229	-2	116	-102	-17	126

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
77	82	-41	65	-12	87	-23	31	-81	64	-77	-124	-137	-73	-99	-124	-147	-105	-85	-77	-74
132	153	-83	206	45	378	26	132	-94	165	-223	-344	-368	-353	-258	-567	-510	-326	-286	-201	-389
111	134	-90	148	2	285	1	69	-98	116	-133	-224	-256	-223	-193	-395	-334	-192	-192	-150	-232
-1	15	-19	9	-17	34	-6	0	0	20	7	-3	16	-8	2	-61	1	-9	-5	-2	-12
76	104	-62	64	-17	121	-22	35	-86	77	-39	-123	-117	-126	-86	-190	-115	-108	-120	-54	-95
128	141	-69	197	56	377	40	124	-88	159	-202	-370	-326	-384	-208	-649	-474	-361	-332	-140	-434

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-92	-106	-177	-88	-43	147	88	84	10	110	-1	71	62	20	95	89	102	-16	122	-75	94
-315	-338	-595	-298	-234	287	242	204	36	281	54	190	252	146	295	186	317	-82	481	-182	287
-195	-218	-408	-194	-157	195	150	141	45	172	40	128	196	62	143	125	242	-54	323	-169	218
27	-29	0	-23	-10	6	-4	-2	-45	-12	-40	13	-4	31	21	24	-10	8	81	-4	-46
-73	-124	-154	-123	-65	104	123	54	-21	51	-7	54	74	19	55	68	107	-6	191	-86	62
-254	-360	-552	-341	-201	287	218	208	9	258	23	178	257	110	251	236	338	-50	516	-139	312

S1	S2	S7	S8	S9	S10	S15	S16
-44	-75	-212	-36	-115	0	-17	-99
-133	-104	-723	-88	-248	18	-98	-274
-62	-62	-478	-32	-189	-4	-70	-168
17	30	0	-28	-6	-7	8	-17
-16	-51	-176	-64	-161	28	-43	-42
-138	-130	-683	-116	-292	56	-124	-275

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT 15X UNDER ACTION τ,

STRESS τ, lb/in²	MEAN VALUES e_x	e_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-371.60	-258.0	21.1	64.9	-355	-128	-368	-369	-247	-147	-271	-146	-255	-153	-343	-318	-259	-186	-241	-248	-244
-1118.54	-839.6	54.8	87.6	-1365	-420	-1067	-878	-859	-478	-1207	-499	-922	-493	-1019	-809	-866	-639	-857	-840	-788
-749.97	-564.5	48.3	115.0	-948	-241	-774	-653	-571	-290	-846	-300	-624	-315	-724	-579	-612	-405	-564	-546	-495
0.20	-14.7	23.6	59.3	4	-41	-22	-45	-53	14	-56	63	-8	11	-19	-10	-54	11	-40	5	2
-371.52	-268.3	36.2	133.6	-403	-142	-389	-366	-287	-116	-358	-87	-281	-114	-380	-309	-324	-174	-300	-222	-245
-1110.59	-848.8	65.1	290.1	-1319	-460	-1043	-920	-854	-512	-1258	-472	-920	-501	-1056	-783	-927	-615	-942	-761	-860

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-339	-284	-306	-294	-226	-140	-316	1	130	72	102	46	12	146	-255	36	26	24	32	169	-18
-1175	-803	-859	-835	-808	-544	-1109	134	101	99	243	99	108	416	-349	95	-50	22	104	155	-6
-754	-568	-592	-617	-504	-313	-704	99	71	158	197	61	20	298	-382	121	34	10	81	176	-21
-9	-16	0	-40	-20	7	-33	65	-52	71	64	1	24	44	40	102	-7	27	-31	17	1
-312	-328	-283	-336	-211	-147	-313	103	33	108	127	29	18	155	-278	131	-16	61	26	193	8
-1117	-896	-810	-936	-744	-621	-1034	200	3	120	201	93	123	430	-374	167	-141	64	63	156	0

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
83	-26	-52	74	-37	12	-42	-30	124	-127	-127	157	-334	272	-558	-112	-21	8	-89	-319	423
-145	83	19	119	55	13	30	136	269	-18	-271	-100	-843	416	-1130	-631	30	-591	-487	-299	368
-35	56	8	113	85	-22	6	60	162	-80	-188	83	-649	468	-898	-357	128	-368	-394	-240	471
-76	47	-17	88	-2	12	-10	-24	41	-9	162	187	-18	11	-45	-108	280	-178	-207	165	32
22	129	25	68	-3	-38	-44	-48	36	-63	-137	303	-454	446	-644	-36	226	-151	-359	-162	548
-204	189	106	100	101	-7	34	140	175	66	-284	-15	104	545	-1126	-504	94	-626	-651	-161	395

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-177	-83	-418	-78	-394	-3	-33	22	16	51	-161	-26	-124	24	248	3	137	24	117	39	0
-397	-631	-974	-490	-638	155	-48	203	86	352	-155	97	-314	133	684	110	505	226	479	264	286
-325	-392	-682	-305	-602	37	-74	93	13	207	-241	5	-326	45	551	17	305	132	328	97	158
93	0	164	-190	-229	32	-244	-33	-158	26	-57	43	24	-19	-6	-29	-57	-32	-8	38	19
-227	-15	-430	-98	-626	-9	-146	-34	-83	71	-177	-3	-262	-1	323	-3	154	40	125	64	51
-463	-631	-1019	-428	-788	171	-241	167	-75	309	-166	82	-473	146	606	106	412	229	491	261	323

S1	S2	S7	S8	S9	S10	S15	S16
-384	-122	-281	39	-27	-204	60	-102
-1293	-233	-581	-295	-191	-216	68	-363
-1002	-223	-487	-109	-139	-230	74	-256
4	-24	-60	-59	-48	32	-60	-63
-500	-98	-303	15	-45	-199	101	-188
-1304	-275	-644	-310	-235	-199	77	-457

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT J1X UNDER ACTION τ_i

ELEMENT STRESS τ_i lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-368.62	-286.8	0.6	-89.3	-240	-198	-396	-215	-247	-195	-227	-256	-335	-335	-278	-254	-278	-211	-403	-295	-228
-1107.18	-918.2	31.7	-61.9	-982	-655	-1147	-650	-852	-658	-945	-763	-1190	-949	-857	-797	-880	-833	-1239	-874	-685
-740.12	-612.6	29.1	-6.8	-658	-431	-813	-405	-556	-407	-625	-520	-800	-645	-578	-513	-570	-503	-860	-604	-451
0.19	-4.5	21.0	-8.5	-5	0	-60	26	5	34	-7	8	-9	-17	-4	-13	29	14	-13	-23	29
-368.23	-292.9	12.9	-56.8	-305	-162	-461	-167	-234	-182	-254	-267	-370	-320	-293	-256	-258	-209	-412	-327	-219
-1107.37	-925.3	35.3	-90.0	-1025	-655	-1185	-630	-848	-673	-934	-779	-1233	-935	-861	-798	-894	-844	-1231	-897	-700

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-472	-273	-215	-274	-195	-417	-438	137	-40	20	39	97	85	-116	258	-51	53	-56	53	-17	-6
-1296	-828	-820	-809	-924	-1101	-1294	321	11	122	140	168	171	-74	468	-240	48	-123	121	-2	89
-873	-575	-536	-537	-566	-775	-887	263	-23	91	74	165	111	-90	382	-148	85	-69	122	-8	60
-37	-8	-19	9	0	-26	-21	28	-21	46	21	110	-17	30	47	-21	-26	53	-3	14	12
-455	-288	-212	-248	-212	-428	-481	79	-63	41	41	153	116	-95	276	-78	79	-41	90	-19	25
-1279	-830	-811	-810	-960	-1102	-1285	265	12	126	128	196	181	-36	453	-263	15	-117	136	-8	113

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-57	-138	-67	52	112	-55	46	-209	157	-239	-264	567	-699	303	-637	308	-698	99	309	-586	439
35	-218	-15	232	319	-83	154	-263	264	-222	-442	431	-1108	131	-903	-118	-1255	-282	291	-903	83
-2	-185	-21	134	251	-79	110	-240	226	-248	-268	553	-938	264	-747	129	-1004	-131	310	-751	212
-41	1	42	-3	66	-14	13	-12	-17	36	358	231	-175	174	15	86	-132	-11	65	29	52
-114	-108	-76	94	159	-69	41	-180	132	-229	-119	610	-841	375	-572	319	-811	55	339	-577	395
-1	-206	-22	295	324	-70	154	-248	227	-178	-452	440	-1191	143	-510	-111	-1336	-276	305	-911	92

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-527	371	-522	59	88	-62	144	32	245	17	-35	-68	-5	-127	276	26	36	-152	19	-189	-31
-583	-61	-1004	-373	-302	-52	535	318	572	262	99	145	-78	-139	885	236	260	-45	132	-152	159
-591	150	-859	-253	-146	-146	273	205	348	150	28	9	-130	-140	622	109	146	-76	40	-171	52
-44	203	-170	-331	813	-106	-147	-51	-96	-20	-27	-26	-21	-28	67	-55	7	-26	-40	2	25
-533	499	-589	-184	74	-179	55	0	121	14	9	-59	-97	-192	350	-24	78	-138	-53	-193	-55
-569	-15	-997	-433	-267	-76	425	332	493	266	69	163	-36	-156	915	243	273	-76	150	-140	186

S1	S2	S7	S8	S9	S10	S15	S16
-319	62	-615	103	100	-413	221	-241
-814	-310	-1099	-207	109	-673	280	-409
-613	-212	-860	-48	108	-550	261	-335
-49	-25	-65	32	-39	-11	19	-20
-440	19	-647	127	80	-446	200	-230
-860	-305	-1104	-183	74	-666	228	-389

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT K2X UNDER ACTION τ_1

STRESS τ, lb/in²	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-371.36	-321.6	29.4	30.0	-168	-246	-392	-414	-341	-443	-206	-235	-322	-281	-246	-433	-281	-304	-265	-330	-267
-1120.12	1013.6	100.0	109.1	-928	-874	-1045	-1102	-1179	-1359	-830	-891	-1264	-954	-673	-1176	-891	-897	-1032	-1059	-909
-749.70	-677.8	75.8	123.5	-622	-558	-689	-771	-882	-910	-563	-543	-826	-624	-428	-823	-615	-611	-665	-696	-609
0.32	-26.0	19.7	46.8	-14	-2	-32	-21	-112	-34	-12	-11	11	-12	-12	-31	-29	-10	19	-6	-5
-371.52	-347.3	46.4	60.9	-232	-259	-408	-410	-462	-446	-228	-236	-335	-274	-260	-442	-306	-304	-272	-331	-265
-1120.47	-1022.4	106.6	100.1	-960	-870	-1061	-1094	-1208	-1365	-839	-891	-1283	-944	-683	-1178	-893	-906	-1024	-1061	-897

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-373	-458	-391	-405	-312	-223	-371	-23	60	50	49	-19	76	-12	7	-112	204	-37	168	9	72
-1141	-684	-1090	-1220	-891	-950	-1277	118	262	218	72	57	155	47	57	-218	134	34	229	98	114
-771	-336	-770	-880	-603	-594	-866	36	208	160	66	1	112	15	25	-196	169	-6	223	63	123
-13	-195	-27	-35	-2	12	-39	-108	133	40	67	17	1	49	-49	-123	113	-64	84	-78	67
-393	-647	-426	-450	-313	-212	-415	-101	131	90	87	20	54	44	-39	-178	263	-48	217	-30	107
-1145	-736	-1113	-1208	-901	-933	-1334	59	334	197	100	91	154	104	20	-276	184	24	263	107	123

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
24	40	-127	279	-64	105	0	27	39	-3	-14	24	-316	-118	-351	-42	-218	145	46	-283	-68
121	-5	-26	530	-12	216	160	178	231	154	-22	-219	-589	-442	-760	-548	-539	-163	-128	-479	-400
99	-4	-25	430	-1	163	102	111	137	88	95	-70	-452	-266	-604	-278	-347	-15	-53	-367	-226
14	0	36	60	27	47	-17	68	-73	90	278	74	-147	32	-186	57	8	92	66	-33	60
70	8	-63	323	-27	130	21	61	-15	54	181	21	-398	-82	-453	14	-207	184	80	-293	-4
154	-44	3	534	0	229	159	201	190	200	10	-231	-668	-404	-836	-489	-552	-169	-97	-506	-317

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-234	-75	-177	-141	-179	-26	86	-68	103	27	71	-200	-29	7	259	59	269	101	199	84	136
-581	-717	-530	-645	-462	-34	238	-126	342	220	182	-357	58	318	566	257	870	358	735	399	496
-422	-462	-381	-516	-332	-137	147	-126	189	100	107	-349	37	157	424	163	638	242	586	263	360
-15	106	-25	-290	-22	-99	28	-62	-77	-73	-41	-80	-20	-13	90	-59	139	-17	161	-2	64
-246	-11	-165	-381	-172	-61	76	-127	69	9	43	-183	-31	2	295	20	350	70	291	82	216
-645	-659	-547	-731	-424	-12	239	-183	291	259	138	-328	48	310	631	251	961	334	836	402	537

S1	S2	S7	S8	S9	S10	S15	S16
-151	-10	-226	63	-30	-87	-6	-168
-715	-204	-584	-207	-48	-26	-16	-447
-528	-99	-357	-97	-15	-7	18	-343
-26	36	-18	-29	-26	5	4	-115
-163	0	-236	95	-66	-14	-13	-214
-735	-188	-626	-164	-22	-12	-27	-460

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT STRESS — LGX UNDER ACTION τ

ELEMENT STRESS τ, lb/in^2	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
-367.06	-367.6	37.5	29.7	-208	-259	-387	-462	-379	-338	-442	-310	-286	-363	-427	-347	-355	-407	-349	-437	-501
-1108.67	-1176.5	111.6	107.5	-792	-930	-1151	-1422	-1134	-1134	-1326	-1178	-883	-1265	-1263	-1138	-1074	-1341	-1034	-1470	-1537
-743.33	-796.7	80.2	78.5	-482	-592	-804	-993	-789	-756	-922	-764	-592	-841	-900	-760	-748	-901	-717	-980	-1065
0.27	-17.1	10.6	8.7	-4	0	-27	-13	-19	-8	-38	-8	-5	-24	-43	-5	-21	-13	-3	-25	-44
-369.67	-386.9	44.1	37.4	-207	-271	-405	-483	-395	-353	-472	-338	-296	-386	-463	-365	-378	-437	-348	-472	-547
-1109.33	-1185.1	111.7	105.0	-817	-929	-1165	-1427	-1144	-1136	-1328	-1182	-906	-1271	-1290	-1143	-1087	-1352	-1031	-1480	-1583

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-295	-365	-339	-330	-423	-334	-471	31	20	4	28	66	1	117	-67	85	5	116	13	106	-5
-1066	-1074	-1110	-1022	-1370	-1050	-1463	96	123	-22	155	166	111	259	-20	173	10	277	60	242	42
-673	-758	-732	-705	-924	-711	-1002	70	92	-12	93	118	46	191	-53	176	16	223	35	179	10
9	-18	-5	-7	-35	-9	-37	12	10	-6	24	5	1	13	35	5	13	6	27	6	9
-273	-398	-340	-351	-459	-341	-498	0	65	-26	63	58	6	115	-46	91	24	108	36	88	24
-1050	-1092	-1106	-1037	-1363	-1049	-1462	75	152	-37	181	146	119	242	-3	144	27	262	75	233	57

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
90	-40	36	95	60	58	-21	69	-66	154	-68	-114	-198	-213	-166	-166	-177	-132	-222	-146	-108
169	-98	163	266	278	97	125	122	76	319	-285	-351	-530	-641	-408	-661	-450	-538	-575	-581	-414
124	-69	90	218	169	96	36	116	-2	262	-148	-205	-378	-435	-290	-437	-318	-324	-425	-373	-281
4	-3	-25	22	-2	21	-12	19	-29	46	5	9	-4	14	-3	-17	-17	0	-30	7	-3
58	-24	30	124	58	66	-26	85	-70	181	-66	-106	-209	-181	-171	-193	-164	-153	-249	-148	-130
144	-80	171	258	272	104	115	135	72	333	-309	-344	-545	-626	-413	-674	-444	-559	-591	-578	-456

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-288	-126	-142	-169	-257	45	138	31	58	93	79	45	-108	104	210	191	98	95	83	134	93
-839	-551	-378	-589	-735	149	355	83	244	293	328	161	0	338	590	533	288	402	245	487	430
-573	-348	-241	-398	-464	67	290	46	150	195	229	101	-64	219	411	388	235	241	196	323	286
-9	-15	30	-26	-11	-8	-49	10	15	-9	-20	10	51	12	-1	2	14	-33	25	-4	6
-287	-157	-123	-220	-198	24	63	20	78	70	53	39	-102	103	185	166	133	93	101	136	109
-828	-578	-343	-630	-690	180	345	80	239	305	327	158	13	358	580	540	297	402	250	472	435

S1	S2	S7	S8	S9	S10	S15	S16
-61	-111	-98	-115	-289	17	-106	-19
-274	-336	-210	-565	-698	-21	-428	-203
-150	-238	-145	-358	-540	26	-294	-29
-19	4	-4	-72	-52	75	-2	33
-76	-124	-76	-179	-298	35	-133	9
-305	-303	-141	-571	-726	-14	-433	-125

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT A5S UNDER ACTION S

STRESS S lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
				INDIVIDUAL VALUES OF STRAIN																
6.17	-1.8	3.3	100.3	-1	2	-3	8	6	-2	-1	-3	-14	-9	-29	-3	0	3	-5	5	-8
15.49	-1.9	13.8	821.8	9	11	11	1	10	-9	-8	0	-26	-24	-29	0	11	-7	0	0	-12
7.10	-0.2	15.4	749.6	12	13	7	-5	8	-13	-7	-6	-17	-10	-23	-4	14	0	5	-4	-8
0.10	0.0	15.8	645.4	8	9	4	1	10	-12	-7	0	-11	-1	206	0	7	0	3	-10	-6
15.60	-0.8	26.1	881.4	12	13	0	5	18	-16	-15	-7	-14	-20	186	-7	11	0	1	3	-9
23.76	-3.9	27.6	2791.5	29	17	7	4	19	-22	-43	-13	-34	-21	183	-3	10	-6	1	0	-26
31.14	-6.1	10.9	5656.4	42	13	18	14	25	-21	-99	-31	-40	-24	183	4	16	1	-2	-8	-47
39.04	-11.1	-14.9	9218.1	59	7	29	20	35	-23	-163	-71	-40	-32	190	-4	20	-5	-19	-12	-69

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-1	5	-5	5	0	9	0	39	8	-41	5	-14	-4	3	-7	0	-12	-3	-10	14	14
-24	4	-18	16	4	27	4	126	77	-9	28	-13	-14	36	-17	-27	-25	3	-18	62	8
-13	12	-13	11	11	18	8	120	39	-12	42	-27	-13	27	-18	-31	-20	-3	-28	61	0
-18	-220	-7	10	3	15	14	94	13	55	35	-11	-19	24	-15	-28	-33	-31	-25	48	6
-9	-218	-19	17	6	31	7	132	56	115	34	-20	-34	35	-28	-31	-25	-43	-44	64	-5
-42	-232	-21	16	26	36	16	186	86	97	21	-21	-61	21	-76	-40	2	-29	-40	107	0
-64	-243	-13	13	42	52	21	193	98	101	-27	-7	-133	7	-153	-15	60	0	0	128	26
-95	-244	-19	22	52	70	27	219	95	127	-51	8	-182	-23	-224	1	116	13	14	142	19

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
6	5	24	-9	14	3	7	5	0	1	27	-3	102	52	92	63	36	4	-38	-28	-94
47	25	-3	3	2	28	-14	32	-23	23	291	201	597	518	605	588	191	155	-191	-190	-598
50	19	9	4	-2	27	-4	18	-27	17	261	175	573	462	586	533	156	104	-185	-154	-560
45	8	10	2	-5	29	-1	29	-27	22	221	148	487	408	490	461	138	77	-147	-121	-485
57	24	0	11	1	19	-11	27	-21	14	300	206	641	577	663	644	188	142	-212	-203	-622
126	52	-21	-20	-32	36	-55	26	-79	-9	859	717	1951	1788	1949	1961	668	576	-775	-697	-1892
186	85	-47	-49	-80	27	-178	-5	-217	-46	1683	1467	3893	3595	3812	3862	1534	1263	-1767	-1438	-3777
219	97	-77	-96	-144	-22	-343	-97	-442	-118	2774	2394	6223	5840	6098	6139	2650	2133	-3086	-2447	-6056

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-32	-86	-43	-38	-7	-22	-64	-35	-22	-22	-17	36	-57	118	-18	21	-42	2	-34	58	-1
-546	-530	-483	-245	-199	22	-27	-10	-5	4	-11	145	-49	74	-16	58	10	34	-31	45	29
-508	-491	-411	-230	-192	-18	-70	-67	-26	-34	-96	96	-167	63	-31	18	-14	-10	-44	8	-23
-443	-403	-364	-210	-182	-9	-100	-70	-50	-45	-116	76	-186	47	-14	0	-37	-10	-27	-17	-22
-608	-550	-495	-279	-256	-32	-154	-66	-132	-70	-169	10	-240	23	-71	-18	-107	-15	-128	6	-59
-1869	-1809	-1688	-809	-808	-65	-148	-142	-193	-125	-265	-98	-303	47	-106	-29	-74	-19	-128	11	-71
-3739	-3731	-3458	-1612	-1592	-20	-120	-109	-219	-134	-314	-123	-279	59	-127	-11	-55	61	-116	2	-64
-6018	-6000	-5649	-2714	-2610	-58	-192	-151	-236	-189	-429	-220	-312	25	-204	-55	-41	14	-143	-94	-107

S1	S2	S7	S8	S9	S10	S15	S16
-29	-30	3	9	-1	14	-40	6
-83	-17	36	34	12	-2	-29	-5
27	-59	11	-12	35	9	-36	24
-95	-29	9	-39	37	18	-3	6
9	-70	18	3	-5	-59	-42	-27
-103	-119	15	-44	16	-48	-35	-7
-22	-143	41	-59	-61	-9	-28	7
-52	-175	61	-115	-164	-39	-53	-21

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT B15 UNDER ACTION S

STRESS lb/in	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
7.85	-2.7	0.0	192.6	-7	-4	0	2	-7	0	-3	-5	-8	13	6	-2	-7	-14	7	-2	-6
16.37	-3.5	-6.0	962.6	-7	6	6	12	-12	-10	-22	-48	-10	34	10	12	-17	-14	-5	-17	-10
6.88	-2.1	-1.7	898.8	-2	18	6	7	-10	-12	-20	-47	1	22	13	7	-12	-7	-5	-19	-7
0.0	1.6	-0.5	825.3	5	18	8	9	0	-12	-17	-44	4	18	19	2	-5	-4	-5	-24	2
15.82	-2.2	-2.8	967.3	-6	12	7	11	-11	-8	-21	-46	-6	37	13	16	-13	-13	-5	-12	-5
23.57	-5.8	-11.2	2109.3	-1	26	17	17	-16	-14	-50	-102	4	50	20	19	-25	-20	-19	-37	-17
31.47	-8.1	-25.3	3921.4	1	34	35	21	-9	-26	-81	-162	15	69	38	27	-33	-31	-34	-69	-18
47.00	-11.8	-23.5	8946.2	28	62	68	22	5	-31	-146	-253	29	81	67	36	-44	-42	-58	-116	-26

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-9	-1	-1	-2	-4	-2	-3	3	0	-7	-2	-6	-1	-13	-1	-4	3	-20	8	-5	7
11	-2	4	0	-4	3	-4	34	-10	12	26	-9	-4	-2	1	-29	16	-63	8	-9	-1
20	1	-2	4	-2	0	-6	28	-11	18	25	-14	-7	5	2	-28	21	-60	9	-14	0
22	10	26	10	1	1	-7	23	-14	27	17	-14	-9	12	16	-34	12	-50	0	-11	-2
12	-6	0	-1	-5	4	-4	37	-8	24	15	-5	-4	-2	-2	-27	11	-63	9	-13	5
28	-11	3	0	-2	6	-14	57	-44	52	29	-12	-10	9	0	-33	40	-95	9	-10	-2
44	-9	6	0	1	8	-23	51	-103	74	22	-12	-17	8	8	-12	85	-104	4	6	-42
41	-9	10	7	10	15	-42	-6	-264	62	-54	7	-64	12	44	93	202	-66	-26	58	-163

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
107	-6	-4	-7	-1	-2	-17	0	-6	-18	103	39	123	105	129	113	68	35	-41	-63	-133
132	-4	0	-23	15	4	-7	-8	-27	-99	341	165	608	641	620	622	312	263	-267	-315	-631
137	-6	12	-21	20	-14	2	-28	-18	-96	320	136	591	609	597	582	294	235	-234	-281	-594
140	-2	31	-27	26	-24	13	-34	-6	-84	308	117	564	570	551	491	276	204	-217	-247	-548
139	-17	12	-25	39	-11	0	-20	-27	-111	343	145	640	648	656	608	327	244	-268	-314	-646
174	-11	6	-55	50	-23	7	-51	-60	-220	678	352	1388	1376	1398	1307	697	587	-622	-725	-1385
262	-37	-13	-125	65	-70	8	-108	-123	-370	1210	729	2609	2513	2577	2435	1280	1154	-1187	-1374	-2540
454	-104	-61	-279	68	-195	-2	-240	705	-669	2646	1841	5696	5661	5508	5651	2875	2767	-2755	-3174	-5788

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-115	-130	-112	-97	-46	-22	-31	-24	17	-3	21	2	-17	8	0	-9	40	47	-46	6	30
-621	-655	-649	-326	-202	19	-60	27	15	6	0	49	-64	90	42	95	67	100	4	29	12
-565	-615	-611	-302	-176	5	-33	10	-2	-16	-45	10	-86	46	2	54	5	57	-53	42	-2
-507	-575	-560	-274	-161	-1	-19	49	0	-1	-58	9	-74	57	37	57	24	42	-51	35	-22
-598	-665	-634	-347	-186	14	-71	33	-17	-18	-45	13	-98	98	11	76	49	72	-63	30	-20
-1327	-1430	-1419	-692	-440	18	-77	17	-16	18	-51	33	-125	153	37	142	66	110	-43	55	-101
-2467	-2604	-2590	-1245	-875	-12	-93	26	-99	-3	-80	-18	-138	163	9	130	46	132	37	25	-173
-5740	-5795	-5835	-2726	-2106	-9	-138	62	-67	45	-108	-31	-117	226	-64	217	-23	250	23	97	-319

S1	S2	S7	S8	S9	S10	S15	S16
12	-4	39	0	-37	-28	-15	-24
60	-4	195	41	-60	-115	-9	-47
35	-21	70	33	-35	-96	7	-25
21	-21	59	-35	-6	-96	16	-10
36	-15	103	21	-58	-142	-7	-45
79	-18	132	29	-71	-210	-13	-72
117	-11	171	31	-128	-310	-18	-72
163	1	279	-31	-168	-507	-21	-79

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT C25 UNDER ACTION S

STRESS	MEAN VALUES			INDIVIDUAL VALUES OF STRAIN																
S lb/in	ϵ_x	ϵ_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
8.63	28.3	1.9	107.1	-2	-4	593	-51	2	1	8	-1	-11	-7	91	0	9	1	11	-4	10
24.58	29.3	5.0	838.3	14	13	599	-32	0	-19	3	-26	-14	-13	80	1	18	-9	21	-5	0
11.88	31.5	10.8	731.6	16	22	603	-39	4	-12	-2	-20	-10	3	86	7	14	-3	19	7	2
-0.15	30.4	11.8	560.8	32	14	605	-50	4	-10	-3	-22	9	13	89	0	8	-6	23	3	-11
24.42	26.5	8.7	854.9	5	4	590	-44	-1	-24	2	-26	-13	-20	81	-1	16	-9	23	-1	0
36.50	27.3	4.7	1979.0	22	26	607	-29	-9	-27	-9	-43	-8	-17	79	-1	17	-13	32	-2	-21
48.69	23.9	-7.3	3693.9	10	31	610	-32	-9	-36	-25	-73	-10	-15	77	-4	14	-27	36	-14	-31
61.16	25.4	-35.3	6192.4	4	36	610	-27	-15	-38	-43	-87	-7	-3	78	4	8	-12	42	-16	-33

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-6	3	-9	16	7	11	10	32	9	13	1	-10	-3	3	9	0	8	0	10	12	0
-11	-5	-27	19	14	40	43	84	45	27	13	-38	-14	18	4	-9	3	-22	-2	12	-18
-14	-6	-20	12	13	35	33	72	39	19	14	-23	-8	29	0	-5	6	-14	-1	15	4
-7	-1	-15	6	4	31	12	42	17	12	5	4	-17	37	-5	1	0	-16	-3	8	3
-22	-7	-33	24	4	43	37	70	60	14	20	-27	-8	19	-28	-18	-1	-29	-5	13	-35
-25	-26	-28	17	12	57	47	91	93	-11	-1	-66	-25	14	-18	-1	8	-12	4	19	-40
-35	-34	-30	22	14	63	60	33	94	-25	-14	-86	-57	6	-30	36	35	-12	22	11	-55
-48	-35	-35	41	35	72	95	-53	96	-24	-77	-116	-109	-23	-51	86	91	4	27	-6	-70

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-3	0	5	7	14	9	4	-1	16	-1	51	18	122	45	99	34	60	25	-41	-12	-101
0	-11	10	15	20	15	47	-24	-3	-2	255	177	647	500	615	514	314	225	-251	-195	-609
10	-12	13	16	34	17	45	-12	14	6	221	152	571	449	543	465	274	184	-216	-155	-524
7	-17	13	13	21	14	22	8	10	16	153	121	405	378	411	383	200	145	-151	-138	-378
13	-23	7	9	20	-11	32	-11	-8	2	242	152	649	570	618	549	259	234	-251	-213	-587
44	-36	-4	9	31	-18	63	-44	-52	-16	550	462	1392	1259	1387	1280	650	554	-591	-530	-1322
89	-55	-31	16	26	-48	57	-86	-128	-82	1087	918	2472	2321	2527	2356	1162	1071	-1123	-1044	-2448
133	-75	-58	19	16	-68	21	-166	-259	-180	1891	1619	4046	3865	4170	3912	1889	1777	-1868	-1798	-4132

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-36	-112	-24	-44	3	18	0	10	73	-5	35	0	7	18	43	41	97	65	23	47	67
-514	-608	-493	-244	-187	2	5	-7	67	-30	-45	-41	-57	58	28	83	34	96	30	101	76
-442	-536	-410	-207	-144	4	-26	8	30	-17	-71	-6	-106	57	47	86	61	99	0	99	71
-360	-361	-343	-156	-130	-38	-97	-6	-49	-15	-90	-12	-144	23	-10	42	-3	21	-15	59	45
-534	-597	-515	-241	-200	-40	-49	-48	-1	-76	-172	-71	-196	16	-13	42	-57	63	-30	47	18
-1236	-1333	-1240	-569	-507	-6	-127	-62	-42	-68	-204	-131	-247	58	7	128	-20	146	-26	94	54
-2276	-2450	-2313	-1168	-753	10	-163	-112	-126	-87	-258	-180	-312	58	-2	174	-46	158	-17	65	54
-3910	-4048	-3874	-2022	-1693	67	-205	-69	-219	-53	-327	-200	-398	157	0	249	-19	244	-21	117	73

S1	S2	S7	S8	S9	S10	S15	S16
-3	12	68	92	-12	-2	-29	35
20	41	150	158	-67	-41	-60	-54
19	18	126	104	-34	-24	-21	-43
-4	13	38	61	-10	-43	6	-78
9	0	132	96	-53	-68	-61	-69
31	-15	154	159	-83	-76	-94	-99
52	5	259	172	-135	-131	-122	-157
87	6	349	179	-136	-160	-157	-152

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT DGS UNDER ACTION S

STRESS	MEAN VALUES			INDIVIDUAL VALUES OF STRAIN																
S lb/in	ε_x	e_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
49.09	3.5	-6.1	302.8	-8	42	-5	21	-7	1	-7	8	-12	14	-34	10	-10	5	4	11	14
147.68	11.0	-26.9	1064.1	-44	77	-14	79	-17	32	-43	47	-26	31	-88	16	-24	28	38	25	65
97.82	12.5	-9.7	775.3	-24	42	3	57	-3	28	-27	52	-4	18	-63	4	-11	22	21	18	65
0.0	2.6	7.2	90.1	1	0	20	-4	7	-7	1	3	3	-3	-2	1	8	6	-1	-8	16
49.62	3.7	-4.7	374.1	-16	38	2	22	-5	2	-14	1	-8	13	-34	15	-9	11	6	6	25
146.36	8.0	-25.6	1077.7	-51	78	-15	72	-21	21	-46	46	-33	29	-94	18	-26	24	32	23	70

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
27	0	-4	-8	-11	14	18	-103	-11	-66	60	-69	48	-26	94	-18	-58	-6	-30	-1	24
92	-16	-28	-32	-36	50	54	-314	-67	-196	147	-227	137	-101	271	-50	-210	-34	-139	-18	71
73	-1	-20	-18	-24	44	47	-247	-35	-145	98	-175	102	-105	214	-24	-159	-20	-83	-13	75
-1	1	-6	1	2	20	1	-47	4	-10	-17	-18	-17	-17	16	22	-13	0	2	4	25
27	-9	0	-12	-10	23	14	-125	-15	-75	33	-98	31	-57	123	-1	-66	-18	-35	-15	57
83	-18	-30	-35	-41	53	52	-319	-84	-194	122	-236	102	-109	271	-51	-208	-43	-130	-25	93

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
8	49	10	-41	-11	-15	-10	-10	-7	49	86	180	164	210	155	126	166	104	-134	-96	-185
-12	210	0	-153	-23	-75	0	-75	40	113	321	590	566	814	545	450	485	364	-435	-430	-615
0	198	-1	-118	4	-68	-8	-44	31	123	224	419	425	640	403	341	356	254	-324	-278	-451
-10	40	9	-24	21	-22	-24	3	1	21	12	21	81	98	60	36	63	-1	-41	-22	-49
-12	70	1	-52	0	-35	-35	-19	-11	61	93	203	223	287	202	153	207	110	-173	-123	-223
-18	208	-3	-149	-30	-87	-16	-75	33	91	314	588	583	824	551	453	494	363	-450	-451	-628

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-165	-174	-171	-142	-70	-44	15	-33	31	-67	8	-10	129	57	9	-3	64	-69	-29	-39	-4
-597	-603	-655	-476	-269	-246	-13	-165	12	-232	26	-156	348	35	-49	-252	99	-168	-14	-83	107
-424	-422	-491	-336	-186	-226	-60	-136	-52	-222	-31	-158	269	-21	-87	-196	23	-170	-45	-29	5
-21	-53	-47	-44	-19	-44	-132	-42	-157	-81	-133	-80	-33	-30	-49	-82	-12	-101	-59	-72	-20
-178	-212	-213	-194	-90	-110	-71	-82	-101	-141	-86	-106	115	-35	-49	-139	16	-161	-49	-66	-26
-577	-608	-654	-493	-288	-287	-56	-209	-136	-287	-89	-214	272	-28	-112	-322	52	-252	-103	-103	49

S1	S2	S7	S8	S9	S10	S15	S16
77	134	104	103	-82	-57	-127	8
243	426	280	267	-276	-269	-386	-24
152	278	173	176	-196	-200	-273	-6
-31	-27	84	-26	-18	-29	-20	-6
66	120	142	79	-137	-99	-145	-38
237	345	251	224	-325	-333	-419	-57

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT E5S UNDER ACTION S

STRESS	MEAN VALUES			INDIVIDUAL VALUES OF STRAIN																	
S lb/in	ϵ_x	ϵ_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	
6.57	1.5	-3.7	221.3	-5	20	-3	22	-8	-1	-15	29	4	0	10	0	-5	-6	20	-4	-10	
12.46	0.9	9.8	1403.1	9	47	-12	64	-30	5	-64	2	28	12	12	20	-17	-4	-10	-9	-15	
5.44	3.8	11.8	1364.2	11	55	-16	63	-21	10	-64	15	46	14	5	28	-13	2	-15	-6	-15	
-0.13	5.0	21.8	1285.2	11	52	-10	51	-27	6	-60	13	60	16	5	23	-9	-1	-19	0	-9	
11.57	4.2	17.5	1430.7	12	58	-12	62	-20	6	-61	14	38	1C	16	24	-16	-3	4	-3	-12	
17.59	1.5	22.5	4079.8	16	84	-23	93	-40	9	-106	-26	55	18	21	43	-24	0	-10	-9	-22	
23.88	0.9	27.4	8708.1	25	136	-25	116	-45	6	-157	-82	80	26	21	54	-35	8	-28	-20	-23	
X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	
-5	12	-14	1	-5	4	-1	10	-3	8	-8	0	-3	15	22	6	-29	8	-10	8	19	
-23	18	-20	2	0	0	4	-2	36	4	94	9	115	40	133	-14	-64	0	-7	10	66	
-12	4	-14	-3	11	-12	19	3	58	20	92	7	104	40	125	-11	-52	-1	3	20	56	
0	0	0	-2	10	-7	22	18	88	51	96	32	98	32	116	1	-29	5	9	25	54	
-19	14	-18	0	6	-8	8	-3	51	24	86	22	100	46	122	-5	-66	5	-9	14	59	
-49	10	-24	0	15	-19	24	-31	45	2	173	11	228	79	277	-19	-95	-13	-20	28	62	
-67	9	-34	8	21	-25	52	-43	37	39	250	37	345	114	420	-15	-146	-18	-54	61	17	
Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	
12	9	-10	17	-1	9	10	19	-110	23	43	27	172	122	137	163	54	81	-39	-68	-136	
42	23	-30	49	-11	25	-13	25	-153	-22	265	261	1030	924	956	1034	356	452	-357	-431	-914	
55	10	-19	46	-16	30	-20	20	-141	-9	248	249	1004	884	950	1033	343	452	-336	-418	-885	
65	9	0	51	-33	31	-33	17	-120	6	226	249	940	834	900	998	359	451	-296	-407	-826	
49	23	-24	48	-1	30	-12	19	-138	-13	261	252	1051	952	983	1065	369	480	-351	-455	-916	
119	28	-35	80	-37	30	-47	0	-196	-142	989	1049	2788	2606	2635	2842	1105	1277	-1082	-1337	-2579	
180	-2	-51	108	-33	27	-93	-68	-240	-332	2387	2546	5778	5331	5502	5849	2493	2655	-2544	-2853	-5457	
S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	
-139	-196	-155	-40	-72	42	22	18	-5	9	32	13	17	68	21	40	-2	52	32	74	127	
-947	-1087	-985	-281	-317	64	28	0	-30	8	25	-25	23	84	32	136	4	157	77	141	105	
-931	-1052	-872	-251	-283	54	36	21	45	6	20	11	24	113	31	136	8	108	88	146	114	
-881	-945	-812	-213	-238	58	68	-6	-27	-9	28	15	5	63	45	37	29	96	92	129	144	
-964	-1084	-898	-301	-316	18	12	3	-133	-3	-68	-34	7	67	24	81	-23	139	43	111	93	
-2702	-2876	-2540	-986	-1114	41	54	-35	-144	9	-51	-91	3	72	13	79	-33	159	57	179	-31	
-5677	-5841	-5271	-2339	-2563	22	52	-86	-180	-44	-112	-152	16	75	-1	133	-119	171	42	198	-237	
S1	S2	S7	S8	S9	S10	S15	S16														
3	2	57	-1	25	8	18	5														
35	39	84	-1	32	-35	-1	-31														
4	31	52	6	42	-10	21	-42														
7	29	-2	-39	66	0	40	11														
29	13	87	-24	60	-55	9	-62														
27	60	72	-21	55	-154	-20	-83														
28	72	58	-58	13	-274	-26	-73														

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT F1S UNDER ACTION S

STRESS S lb/in²	MEAN VALUES ϵ_x	ϵ_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
13.46	2.4	-1.7	280.1	33	-2	18	-3	-15	-14	-5	-24	41	4	1	5	2	-14	-4	-4	27
19.52	4.8	-8.1	849.4	97	20	26	13	-38	-38	-30	-49	69	25	7	12	-4	-25	-28	-16	43
13.36	4.4	-4.5	799.3	104	24	27	8	-36	-38	-35	-47	65	25	3	7	-7	-26	-31	-20	44
-0.02	1.8	1.3	620.1	113	35	17	6	-20	-39	-34	-40	58	18	0	6	-9	-19	-53	-25	24
19.59	5.3	-10.2	946.1	121	28	32	9	-43	-44	-35	-49	72	27	6	12	-8	-28	-30	-16	39
29.16	3.8	-46.9	3019.4	167	64	46	24	-61	-67	-98	-95	88	59	20	14	-20	-45	-77	-35	39
39.01	3.5	-103.1	6308.2	173	85	55	40	-59	-77	-149	-137	97	67	31	20	-17	-50	-110	-45	30

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
1	1	-6	4	-7	-9	26	-66	-34	-11	28	-31	-4	-23	4	30	-3	-40	24	-13	40
18	1	0	9	-11	-9	24	-106	-115	-4	20	-50	-23	-32	0	54	-2	-48	21	-13	46
12	2	-6	3	0	-1	29	-84	-98	0	18	-48	-17	-32	-10	49	-4	-39	13	-9	35
-4	7	-10	-9	2	5	15	-40	-40	-6	26	-29	-12	-7	-25	30	-5	-14	-19	-8	11
19	5	-7	1	-7	-3	25	-110	-116	12	5	-48	-34	-32	-1	66	-14	-39	1	-4	22
40	16	1	1	-19	-1	28	-278	-280	-21	-32	-53	-72	13	-20	77	-36	-40	-26	-5	-35
46	34	-3	28	-9	8	25	-404	-523	-69	-113	-76	-124	16	3	94	-55	-30	-87	-20	-131

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
9	-4	-17	8	3	24	34	23	-17	-5	48	45	118	174	167	281	77	91	-42	-42	-161
17	-18	-35	21	13	70	-2	63	-37	-17	117	93	534	547	584	698	268	292	-159	-134	-521
25	-13	-27	33	3	67	-4	57	-19	-8	111	86	517	522	562	662	249	279	-143	-109	-498
21	-2	-4	40	-17	55	-43	52	-14	11	61	38	415	440	443	516	199	229	-107	-73	-386
28	-27	-26	21	11	54	5	40	-34	-25	122	108	606	606	659	768	293	327	-180	-150	-581
35	-74	-64	74	-13	105	-78	43	-129	-156	542	645	2030	1869	2053	2174	849	898	-674	-606	-1941
30	-133	-57	161	-13	154	-151	19	-267	-369	1580	1667	4070	3811	4183	4299	1750	1730	-1584	-1450	-4077

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-196	-173	-213	-81	-184	-45	29	-15	-11	20	-36	-62	30	22	-34	93	-26	3	26	-37	13
-545	-627	-647	-198	-397	-52	-5	8	11	31	-67	-95	25	-6	-39	122	-37	37	12	33	-20
-506	-601	-610	-163	-361	-53	-36	-2	-12	27	-45	-95	-7	14	-6	68	-36	38	55	-9	-14
-388	-486	-489	-98	-257	-66	-70	-12	-51	-17	-88	-75	-32	9	-28	64	-56	53	4	-11	-34
-597	-703	-727	-227	-432	-37	-31	6	-7	24	-89	-102	-6	20	-11	112	-68	30	45	5	-52
-1941	-2194	-2153	-836	-1193	-63	-35	10	-23	24	-121	-169	-29	-2	-40	115	-99	57	-41	33	-58
-4086	-4343	-4199	-2018	-2374	24	-19	104	-21	64	-96	-102	-6	73	1	174	-98	161	-26	90	-168

S1	S2	S7	S8	S9	S10	S15	S16
56	32	3	33	-27	131	-10	-25
69	44	40	33	-31	112	-48	-41
66	33	26	16	-23	113	-33	-62
23	15	2	-2	-6	156	-18	-97
74	55	46	7	-17	113	-54	-66
128	26	82	20	-58	26	-96	-43
133	26	150	66	-100	-150	-122	-128

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT HGS UNDER ACTION S

STRESS S lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
49.62	6.3	-8.6	338.1	22	25	8	17	6	8	2	-14	33	5	6	1	-3	10	-13	-8	49
146.08	26.4	-45.7	1053.7	59	81	32	58	26	19	42	-41	106	57	30	4	-28	16	-11	-9	157
98.49	24.0	-23.0	637.7	46	61	30	45	36	22	30	-36	82	61	29	0	-21	18	-12	0	132
-0.06	4.0	6.8	145.1	8	7	7	10	25	-7	10	-29	9	17	18	0	-8	11	-9	-3	23
49.22	7.8	-2.6	440.6	22	31	11	25	19	0	20	-23	36	12	21	4	-8	13	-6	-17	51
147.59	27.7	-37.3	1085.2	58	76	31	61	33	19	55	-44	111	52	28	7	-30	14	-6	-17	165

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
32	10	-47	-2	-6	-2	9	-68	24	5	19	22	8	14	-54	-53	-111	1	-27	10	32
98	25	-104	-8	-13	6	27	-243	0	33	91	120	-3	15	-217	-143	-355	43	-153	46	12
71	22	-67	0	-11	15	22	-176	18	42	91	105	-10	21	-183	-97	-269	49	-129	49	73
-14	10	-7	0	1	5	5	-20	63	24	33	23	-2	11	-24	12	-39	19	-23	9	-1
7	11	-47	-9	-3	-1	15	-85	52	0	49	33	12	6	-46	-44	-134	24	-48	13	47
98	24	-96	-11	-8	6	32	-227	3	27	108	114	3	9	-212	-140	-371	48	-165	46	120

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-16	55	14	-97	45	-58	59	-34	39	0	144	100	153	219	216	205	152	79	-122	-167	-191
-66	198	60	-324	118	-186	205	-106	74	-25	398	329	526	882	782	776	438	267	-378	368	-656
-41	158	43	-251	103	-142	150	-67	67	18	287	233	407	715	616	610	318	200	-255	-437	-501
9	4	20	-22	-1	6	-9	17	-55	35	22	23	64	154	110	125	29	16	-9	-42	-88
-15	58	37	-126	59	-51	61	-20	2	30	153	130	202	302	303	276	186	78	-141	-197	-257
-71	201	57	-321	142	-180	206	-90	48	-10	426	320	568	872	844	753	487	244	-427	386	-711

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-162	-160	-265	-156	-104	19	68	24	30	28	11	-23	-24	127	-27	95	-2	84	-61	120	12
-637	-536	-979	-506	-398	19	184	108	38	70	0	-28	-41	301	-127	339	-135	260	-208	293	36
-495	-406	227	-380	702	-16	179	87	-4	52	4	-26	-32	202	-84	291	-73	189	-164	222	100
-88	-57	-146	-48	-56	-73	70	-15	-38	12	-16	5	-37	7	-4	25	26	-17	0	11	57
-205	-203	-344	-223	-158	-46	88	5	6	10	-8	-26	-20	77	-58	98	-9	64	-37	103	48
-603	-595	-951	-545	-406	-58	194	85	29	64	-16	-76	-43	303	-153	338	-138	270	-200	336	37

S1	S2	S7	S8	S9	S10	S15	S16
44	101	174	92	-52	-129	-38	-42
121	354	556	177	-131	-424	-87	-91
51	259	410	142	-59	-270	-70	-84
-43	4	26	20	38	6	34	16
4	105	212	74	-50	-125	-22	-51
107	337	611	158	-167	-411	-107	-111

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT I5S UNDER ACTION S

STRESS — MEAN VALUES — INDIVIDUAL VALUES OF STRAIN

S lb/in	ε_x	ε_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
12.09	3.1	-1.2	242.9	10	12	0	20	-7	19	8	-19	5	9	-10	13	-11	-25	-6	10	-16
19.36	4.0	3.0	752.5	16	25	-8	33	-17	29	2	-46	0	10	-15	19	-3	-13	-9	7	-39
9.16	6.1	7.3	652.3	10	40	-2	24	-9	52	-8	-38	-2	2	-12	21	-5	4	-9	4	-33
8.02	3.6	7.7	535.7	-7	30	-2	12	-1	52	-14	-20	11	-25	-9	9	-5	1	-3	-2	-12
19.51	2.4	6.0	766.7	21	22	-12	30	-18	37	7	-53	-4	16	-16	12	-4	-20	-10	5	-44
29.49	-1.2	-4.9	3013.4	24	62	-8	73	-40	20	-36	-153	15	27	-6	34	-17	-13	-34	-17	-65
39.11	-13.5	-41.5	7382.7	42	104	-2	113	-68	10	-104	-252	24	20	14	54	-54	-15	-52	-75	-105
46.42	-19.3	-84.8	11582.3	47	141	5	153	-80	8	-185	-308	26	14	20	80	-64	-14	-69	-99	-152

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-3	2	5	18	-1	13	27	-1	25	-70	27	-29	19	-21	-5	35	5	26	-8	8	9
-26	0	4	30	2	38	57	-12	39	-79	44	-62	15	-61	-39	88	41	33	-15	-5	3
-12	0	13	25	-3	33	52	0	6	-69	8	-54	-10	-53	-28	92	64	17	-22	13	0
-7	6	12	13	-3	20	33	-3	-30	-47	-31	-38	-28	-50	-21	68	70	4	-31	30	8
-28	-6	-1	30	3	35	58	-23	21	-89	40	-67	9	-68	-61	92	39	26	-43	-2	12
-72	-13	-8	41	34	33	89	-91	12	-147	28	-160	-56	-121	-133	173	122	25	-28	-29	-31
-165	-30	-17	47	64	9	114	-217	-183	-233	-110	-235	-177	-109	-223	270	193	30	-13	-68	-79
-232	-31	-20	64	84	0	147	-379	-384	-333	-275	-293	-265	-74	-251	333	248	14	9	-115	-141

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-16	-7	-15	-14	-17	24	-5	15	47	-6	88	41	168	173	184	186	84	33	-9	-50	-220
7	37	-40	-9	-35	73	9	24	102	-65	198	139	546	526	523	583	218	137	-105	-188	-532
25	47	-39	-7	-13	86	14	33	75	-44	168	129	503	443	455	498	183	112	-93	-131	-448
44	44	-36	-19	-7	105	2	31	54	-26	127	111	443	360	376	436	127	79	-89	-76	-335
14	50	-57	-5	-47	95	17	16	96	-56	204	109	576	541	554	594	215	118	-121	-189	-544
44	65	-48	16	26	124	107	0	126	-196	742	679	2135	1953	2037	2132	810	760	-636	-885	-1922
84	76	-68	125	42	166	130	-28	15	-362	1881	1871	5049	4649	4853	5058	1959	2035	-1775	-2256	-4641
65	53	-18	247	24	227	98	-32	-131	-508	3071	3075	7817	7163	7453	7804	3181	3269	-3028	-3548	-7234

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-155	-177	-145	-93	-19	63	-21	52	24	59	-24	43	-73	40	18	10	5	-9	59	62	-2
-509	-512	-430	-263	-176	59	-5	35	-6	48	-80	0	-112	27	-8	43	1	33	93	39	1
-446	-466	-415	-227	-150	62	-31	10	-36	38	-83	-14	-108	26	-29	5	2	-40	77	34	-6
-371	-393	-326	-196	-143	25	-87	-48	-103	-1	-93	-24	-90	-34	-33	-38	-36	-32	78	120	0
-501	-539	-466	-289	-183	33	-72	-12	-131	36	-155	-4	-203	-36	-48	-61	-12	-41	65	3	-24
-1991	-2202	-1912	-898	-947	135	-45	67	-113	45	-231	-54	-227	10	7	-3	40	-14	93	49	-69
-4844	-5271	-4670	-2176	-2224	208	-66	97	-141	26	-362	-109	-265	-28	84	-36	127	-61	69	-14	-84
-7532	-8142	-7297	-3419	-3572	302	-30	165	-145	-17	-389	-154	-262	-47	155	-67	212	-42	11	-107	-89

S1	S2	S7	S8	S9	S10	S15	S16
62	-18	80	44	37	-25	14	11
43	-27	67	65	4	-51	18	0
-11	-29	43	52	22	3	4	-5
-38	-26	16	-1	2	19	19	-49
31	-47	48	29	-27	-68	-31	-43
12	-70	57	65	-55	-192	15	-60
-39	-94	60	114	-105	-356	-23	-101
-63	-89	90	147	-212	-437	-13	-128

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT J1S UNDER ACTION S

STRESS S lb/in	MEAN VALUES ε_x	ε_y	γ_{xy}	INDIVIDUAL VALUES OF STRAIN X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
13.82	6.1	-3.1	205.5	0	12	4	6	10	-11	-10	6	12	14	3	1	-5	13	-1	5	16
23.88	6.7	-11.0	799.5	13	40	19	16	12	-26	-29	-4	13	31	6	1	-5	13	-2	6	1
8.04	5.3	-4.6	679.2	13	34	19	18	2	-9	-26	7	7	16	17	-2	-2	1	-10	11	-6
0.15	10.0	3.3	546.7	12	40	25	12	7	0	-10	6	7	-2	25	0	107	1	-3	14	-20
23.06	6.2	-6.4	788.3	19	32	26	7	17	-35	-16	-9	18	30	13	-6	-1	4	-2	0	1
35.07	4.4	-34.5	2927.5	25	64	61	14	27	-74	-70	-19	27	48	15	0	3	-28	-10	0	-41
47.03	1.0	-83.6	7228.8	36	84	89	33	21	-75	-111	-14	8	57	2	13	17	-53	0	-34	-75

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
20	7	4	4	13	1	11	29	-6	8	18	-32	42	-19	10	-22	-2	-2	-1	15	-1
1	7	-16	3	18	11	24	64	4	-1	34	-75	65	-55	20	-58	-43	-46	26	7	27
-17	7	-18	18	10	9	24	21	0	-4	22	-44	25	-41	12	-50	-33	-42	25	5	27
-22	12	-13	9	4	9	17	40	-5	18	-8	2	-23	-29	12	-30	-26	-43	8	12	20
0	8	-15	3	16	13	22	33	-22	12	15	-61	52	-47	6	-59	-32	-47	16	9	10
-25	19	-19	22	8	34	20	-33	-26	0	43	-97	51	-115	10	-96	-88	-93	5	15	7
-97	14	-32	45	22	64	9	-222	-86	-46	42	-142	45	-179	36	-126	-165	-134	-14	15	22

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
34	0	-19	-1	-26	0	15	-18	-16	-29	88	57	181	64	139	80	115	57	-95	-12	-135
80	-6	-48	-11	-39	2	20	-2	-64	-29	242	217	676	404	519	403	308	204	-303	-131	-532
62	0	-39	-1	-32	9	3	0	-41	-14	170	172	597	367	451	357	244	180	-241	-105	-443
64	0	-30	9	-16	6	4	9	2	-2	133	102	535	290	377	274	206	144	-189	-76	-352
70	-3	-43	-26	-37	0	10	7	-55	-31	226	180	700	406	532	393	311	184	-297	-145	-513
159	-16	-125	-23	-114	16	-22	38	-171	-118	779	726	2287	1670	1872	1668	977	744	-1011	-659	-1895
249	56	-195	-16	-148	2	-35	20	-347	-356	2019	1872	5185	4302	4634	4280	2429	1855	-2589	-1936	-4626

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-109	-212	-62	-94	-69	27	-24	73	-14	39	-6	3	-74	75	16	71	-3	47	1	37	-18
-430	-736	-401	-262	-263	93	5	46	-28	61	6	1	-87	96	105	88	43	52	1	94	4
-362	-624	-354	-204	-224	36	-32	-2	-68	16	-4	-32	-84	18	109	49	-29	-23	-44	-15	-73
-257	-514	-305	-163	-173	11	-23	-46	-88	18	-65	-31	-74	36	77	40	-48	-32	-72	-15	-96
-392	-734	-396	-268	-269	39	-95	-5	-132	18	-33	-11	-178	53	65	36	-58	-15	-97	15	-96
-1639	-2361	-1746	-989	-929	151	-85	4	-164	55	-93	-12	-204	80	86	49	-109	22	-137	46	-71
-4179	-5260	-4353	-2356	-2231	309	-113	88	-222	152	-114	54	-245	121	225	99	-98	168	-192	111	-118

S1	S2	S7	S8	S9	S10	S15	S16
41	87	101	55	-43	-6	-7	19
81	143	134	91	-72	-38	0	37
28	21	63	44	-59	-37	12	12
8	3	48	13	-17	-55	31	18
64	39	121	39	-79	-133	-16	-8
141	-38	194	14	-180	-161	-26	-28
243	-111	302	-15	-283	-178	-26	-55

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT K2S UNDER ACTION S

STRESS	MEAN VALUES			INDIVIDUAL VALUES OF STRAIN																
S #/in	ϵ_x	ϵ_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
12.27	2.0	4.6	197.2	29	8	12	14	0	7	27	17	-11	-6	-4	11	-8	9	8	-4	-26
25.10	1.3	10.0	908.3	80	29	18	19	1	-1	18	5	5	2	-17	28	-37	17	5	-18	-41
11.60	4.2	18.4	805.8	62	19	19	26	0	6	14	0	-2	14	-12	26	-30	23	8	-1	-39
0.05	3.6	17.4	660.5	50	0	29	5	4	4	-1	-27	13	19	0	5	-17	15	19	-2	-22
25.09	-1.5	13.2	936.1	92	3	27	10	5	-12	71	-3	4	-14	-15	14	-39	1	16	-36	-41
36.76	1.4	30.7	2642.1	152	39	24	25	-1	-4	8	-33	37	0	-22	19	-31	10	21	-25	-53
48.96	9.9	64.8	5378.3	212	61	38	41	9	-15	-10	-40	87	-2	-19	8	-13	5	29	-25	-50
61.20	16.7	109.0	8970.6	260	96	64	44	32	-38	-15	-89	115	-15	-18	1	5	4	50	-36	-46

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
8	-25	-5	-3	-3	-4	0	10	-1	-21	-1	2	12	51	48	-25	-16	-17	28	-5	13
6	-104	-12	-13	12	0	28	40	17	-63	19	26	37	149	115	-92	-10	-62	61	-35	54
5	-94	0	-7	6	16	38	33	15	-55	51	5	46	126	77	-75	6	-47	48	-20	53
-8	-74	-8	22	-10	30	40	31	-15	-31	60	22	33	99	26	-46	5	-25	24	3	40
-7	-97	-22	-6	-7	1	17	47	12	-59	18	28	19	153	97	-91	-18	-58	48	-20	41
-19	-167	-29	-2	11	11	62	109	25	-72	46	68	75	206	205	-170	-8	-75	90	15	80
-19	-214	-29	9	26	26	122	170	56	-78	66	84	149	254	339	-225	30	-43	141	74	112
-30	-250	-40	34	26	54	192	246	84	-42	82	132	224	270	473	-229	69	38	175	155	122

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
20	11	14	-32	-18	-26	28	18	2	4	107	87	131	116	130	134	81	46	-92	-67	-94
42	37	12	-37	-29	-33	71	4	-15	19	323	274	663	620	459	618	276	263	-271	-242	-426
45	40	17	-29	-13	-10	68	10	-17	32	272	228	622	583	454	566	239	224	-231	-195	-363
53	34	15	-27	3	12	50	15	-18	39	173	155	564	531	361	461	184	169	-177	-162	-279
65	23	27	-54	-11	-46	90	-8	-15	12	333	266	688	648	530	660	291	242	-286	-271	-415
120	64	57	-23	-29	-27	88	-16	-10	21	879	745	1896	1779	1589	1788	762	708	-734	-710	-1465
195	81	153	-4	11	-22	90	-66	12	43	1745	1592	3791	3570	3309	3543	1574	1460	-1487	-1456	-3141
277	84	303	2	84	-35	144	-164	75	46	2832	2699	6338	4973	5675	5902	2694	2523	-2544	-2528	-5422

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-81	-118	-70	-94	-73	87	6	33	-37	56	20	68	-87	7	2	-8	17	-24	-59	-33	-16
-495	-671	-585	-311	-312	190	33	70	22	104	27	135	-175	11	31	104	74	48	-74	18	27
-413	-606	-524	-277	-241	117	-46	59	-33	49	-8	82	-204	10	-18	32	59	49	-21	4	-3
-346	-505	-468	-202	-199	79	-21	13	35	20	-13	3	-181	-7	52	104	64	25	22	16	20
-517	-649	-613	-319	-310	170	10	67	-10	91	-21	108	-173	-11	-61	52	2	9	-64	-14	-29
-1564	-1860	-1761	-733	-762	302	45	117	-18	132	-45	200	-209	29	3	85	32	97	-74	300	33
-3265	-3709	-3529	-1575	-1500	479	-40	176	-14	246	-2	314	-256	21	70	142	80	161	-182	131	96
-5613	-6228	-5751	-2635	-2531	619	-20	275	-74	356	-4	442	-217	-20	20	186	23	238	-341	176	116

S1	S2	S7	S8	S9	S10	S15	S16
40	-12	35	145	-19	-99	-80	-20
114	-14	72	195	-23	-69	-58	-42
82	-54	31	34	10	-69	-39	-16
15	-84	13	105	20	-59	-20	9
113	-64	65	130	-4	-104	-30	-28
223	-97	113	115	-6	-90	-40	-37
345	-98	143	169	-8	-24	-14	-50
482	-148	199	178	-4	-4	17	-77

TABLE B3 CONTD.-DATA FROM SERIES II COMPRESSION AND SHEAR TESTS ON PROTOTYPE ELEMENTS

ELEMENT L5S UNDER ACTION S

STRESS	MEAN VALUES			INDIVIDUAL VALUES OF STRAIN																
S lb/in²	ϵ_x	ϵ_y	γ_{xy}	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
49.37	-6.8	16.4	325.0	10	27	14	2	-2	10	-43	-42	30	-18	14	1	9	10	-17	-10	-31
147.28	-17.2	77.6	1170.5	49	20	6	-9	-19	26	-111	-135	122	-1	40	11	32	-7	1	-28	-66
98.56	-8.9	70.4	886.5	43	-20	10	-16	-7	20	-71	-91	96	19	46	15	29	-4	17	2	-48
0.0	-6.2	23.2	153.5	11	-44	10	-40	9	-5	14	-18	23	-8	28	-13	11	-15	17	-3	-5
49.31	-14.5	32.5	441.4	11	-22	14	-28	7	1	-30	-58	32	-38	27	-17	17	-18	-4	-21	-34
148.36	-20.1	84.3	1206.8	46	3	11	-24	-14	14	-113	-144	127	-8	43	7	41	-22	11	-24	-71

X18	X19	X20	X21	X22	X23	X24	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14
-32	-19	-2	5	0	-16	-63	20	-53	39	1	59	-9	69	23	-59	34	-53	28	-39	54
-69	-32	0	43	-22	28	-292	43	-108	130	108	236	3	255	66	-186	156	-167	103	-119	222
-48	-20	9	57	-18	16	-251	-4	-64	94	115	175	15	196	50	-125	118	-114	88	-80	178
-54	0	-3	31	-24	-16	-53	-29	12	-1	57	2	9	20	0	14	21	-13	4	-4	23
-76	-2	-14	35	-14	0	-117	-12	-43	55	47	69	-11	98	28	-61	53	-61	27	-32	65
-87	-35	-6	61	-39	42	-300	10	-107	135	125	237	0	260	72	-187	151	-158	104	-102	221

Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
-2	75	44	65	17	5	21	3	40	-22	142	126	155	295	130	211	100	128	-100	-195	-158
21	357	116	275	75	-1	75	28	56	51	450	423	517	1156	510	855	327	510	-321	-624	-525
13	289	82	262	68	19	65	35	37	63	299	336	361	918	368	717	204	423	-223	-463	-354
1	48	25	131	-12	32	-5	19	-21	29	-4	41	52	224	51	190	-11	120	-8	-77	-1
0	133	51	160	5	7	13	20	20	-4	132	139	189	455	166	360	87	221	-109	-259	-156
41	377	135	273	118	-36	127	-12	96	12	452	443	534	1195	538	901	325	530	-303	-676	-501

S12	S13	S14	S15	S16	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24
-191	-150	-228	-58	-147	33	47	13	-32	62	-11	121	67	-54	14	-63	113	-39	133	60	19
-712	-520	-908	-172	-483	-33	113	103	10	195	-110	397	67	-66	-46	-153	126	-86	366	2	114
-560	-351	-759	-102	-361	-105	66	54	46	116	-75	307	-2	-45	-43	-119	181	-55	305	-26	87
-112	-17	-223	13	-79	-132	-73	-33	17	-46	-99	40	-10	23	-138	-37	13	-19	15	-35	-19
-289	-154	-393	-71	-211	-72	-10	3	-15	45	-122	128	65	-12	-118	-63	51	-34	110	-11	-1
-756	-504	-962	-188	-498	-72	105	97	-34	179	-173	382	99	-64	-85	-137	123	-47	318	14	27

S1	S2	S7	S8	S9	S10	S15	S16
137	167	40	75	-59	-96	-46	-96
476	528	76	216	-147	-271	-98	-285
338	367	0	156	-69	-194	-49	-214
-9	7	-49	-5	25	-33	0	-35
139	186	0	99	-24	-123	-84	-128
474	559	68	229	-125	-319	-152	-326

TABLE B4. DATA FROM PROTOTYPE FLEXURAL TESTS - ACTION M_1

Elements under action M_1				Actual deflection of Target 1	Deflections relative to target 1 ($x10^{-4}$ in.)				
Label	Modulus $x10^6$ psi	Action lb in/in.	Curvature $x10^{-4}$ in.$^{-1}$	in.	2	3	4	5	6
X1	.3737	249.3	4.781	.155	-375	-75	-52	-423	-92
		501.9	8.930	.312	-783	-160	-82	-845	-154
		741.7	15.031	.474	-1136	-157	-118	-1230	-128
		520.1	11.083	.343	-882	-123	-111	-914	-166
		268.5	5.468	.187	-464	-74	-86	-452	-97
		0.0	-0.090	.015	9	-29	-39	-43	-26
		245.6	5.357	.165	-414	-27	-43	-448	-111
		504.6	9.642	.329	-828	-115	-89	-869	-413
		754.0	15.850	.486	-1255	-189	-115	-1262	-165
X2	.4707	203.0	3.538	.172	-259	16	-3	-273	-58
		337.3	7.125	.344	-550	-41	-18	-573	-135
		452.9	10.743	.514	-805	-36	-102	-927	-232
		326.6	8.600	.435	-657	-75	-92	-824	-318
		171.0	6.447	.322	-534	-113	-115	-663	-309
		0.0	2.944	.138	-267	-72	-213	-473	-347
		155.6	5.555	.241	-434	-89	-162	-682	-381
		309.6	7.781	.378	-599	-49	-174	-800	-334
		465.7	11.374	.532	-879	-66	-134	-1032	-346
X3	.4929	149.7	3.486	.180	-205	90	41	-174	115
		235.0	7.503	.352	-490	75	32	-484	106
		308.0	12.093	.524	-791	122	29	-778	194
		223.8	10.069	.464	-680	83	34	-645	133
		117.7	8.385	.364	-550	75	11	-579	71
		0.0	4.875	.247	-366	-30	-26	-406	-84
		106.5	6.642	.348	-446	43	-4	-463	56
		211.5	9.527	.394	-626	113	18	-604	153
		316.5	12.663	.551	-829	160	46	-779	225
X4	.5313	94.8	4.795	.165	-312	107	-76	-356	14
		158.8	9.371	.231	-604	102	-165	-748	58
		216.8	14.055	.397	-937	124	-251	-1149	3
		155.0	13.083	.349	-855	117	-144	-1029	27
		82.0	10.506	.245	-721	123	-114	-781	13
		0.0	3.649	.016	-254	63	17	-210	43
		72.4	5.829	.109	-390	46	-79	-455	22
		146.0	10.340	.368	-682	85	-191	-857	6
		215.8	14.954	.409	-994	152	-259	-1218	-10
X5	.5535	344.2	3.854	.173	-221	91	53	-227	70
		716.7	9.208	.335	-616	116	-23	-619	89
		1079.6	13.906	.505	-901	152	28	-951	121
		726.3	9.413	.360	-608	138	41	-608	100
		376.2	4.958	.205	-343	57	3	-322	38
		0.0	0.288	.024	37	110	-40	-36	15
		359.1	4.829	.186	-313	58	-4	-338	35
		721.5	9.406	.354	-603	112	46	-627	91
		1087.1	13.673	.518	-877	189	75	-872	176
X6	.6101	221.6	3.357	.175	-232	14	2	-284	-81
		365.0	7.135	.344	-563	-85	-40	-587	-120
		491.8	10.736	.516	-834	-136	-23	-890	-197
		354.3	9.180	.458	-723	-100	-6	-720	-136
		186.5	7.041	.346	-591	-94	-119	-612	-165
		0.0	3.170	.154	-169	104	-169	-363	-86
		168.3	5.781	.246	-424	-7	-166	-560	-130
		334.1	8.253	.391	-634	-75	-114	-743	-188
		499.3	11.465	.533	-881	-121	-48	-963	-217
X7	.6454	171.0	3.739	.181	-250	5	94	-179	120
		273.9	7.770	.352	-527	58	85	-433	175
		361.3	12.256	.525	-859	81	63	-742	184
		260.0	10.892	.474	-735	106	116	-620	205
		135.8	9.079	.377	-628	70	134	-479	197
		0.0	4.440	.259	-302	29	36	-255	100
		120.4	6.406	.242	-450	45	69	-368	95
		245.1	9.270	.397	-620	100	95	-506	223
		364.5	12.687	.545	-845	124	139	-728	245
X8	.7060	100.7	2.954	.184	-19	22	421	-100	170
		166.2	6.586	.355	-355	65	228	-336	222
		220.6	12.003	.530	-785	98	298	-593	305
		162.0	10.822	.477	-715	46	265	-580	216
		85.7	7.923	.359	-457	8	122	-567	104
		-4.2	-0.590	.120	-15	-5	-29	72	-22
		76.2	4.784	.255	-220	11	131	-363	70
		152.4	8.336	.410	-453	80	240	-472	231
		230.7	10.805	.559	-719	60	345	-593	83
X9	.7363	448.7	4.586	.158	-422	-129	-77	-424	-165
		910.1	9.277	.321	-771	-157	-60	-722	-97
		1369.0	13.760	.486	-1144	-246	11	-1047	-184
		941.6	9.684	.345	-800	-223	10	-772	-142
		480.1	5.434	.181	-506	-156	-56	-470	-175
		0.0	0.392	.007	-78	-99	-89	-127	-109
		455.0	4.513	.170	-442	-171	-55	-412	-182
		918.1	9.524	.334	-794	-166	72	-687	-125
		1383.9	13.920	.503	-1118	-182	65	-963	-36
X10	.7848	256.8	2.954	.175	-207	-5	-82	-292	-60
		429.5	7.354	.345	-550	-16	-122	-636	-116
		579.7	11.111	.523	-794	13	-104	-877	-51
		420.4	9.715	.461	-701	48	-106	-765	-76
		221.6	7.524	.364	-524	54	-74	-587	-35
		-1.0	4.486	.168	-333	82	-156	-382	-64
		199.8	6.423	.259	-493	-4	-162	-582	-134
		398.6	8.857	.401	-640	21	-151	-761	-121
		593.1	11.538	.545	-808	68	-77	-895	-74
X11	.8192	183.8	3.315	.171	-270	-43	16	-225	-8
		305.3	7.684	.331	-675	-224	-24	-648	-185
		413.5	12.434	.495	-1091	-347	-33	-1064	-349
		298.4	11.482	.441	-951	-331	-75	-1092	-373
		155.0	9.222	.347	-776	-231	-98	-867	-301
		0.0	4.399	.128	-373	-98	-112	-432	-133
		139.0	6.385	.223	-504	-104	-61	-571	-146
		280.0	9.295	.371	-821	-283	-55	-852	-331
		419.3	12.357	.513	-1098	-383	-58	-1098	-392
X12	.8757	116.7	4.104	.165	-317	-56	-1	-344	-83
		199.3	8.763	.317	-723	-216	-176	-885	-300
		266.9	13.427	.473	-1117	-337	-313	-1363	-443
		19219	12.197	.420	-1021	-318	-237	-1220	-414
		108.1	8.871	.300	-764	-299	-155	-904	-327
		0.0	2.079	.067	-151	35	-15	-144	-11
		96.9	4.802	.181	-361	-34	3	-373	-54
		184.3	9.854	.343	-791	-188	-102	-887	-228
		269.1	13.822	.486	-1131	-326	-201	-1318	-390

TABLE B4. DATA FROM PROTOTYPE FLEXURAL TESTS - ACTION M_1

Elements under action M_1: Label	Modulus $x10^6$ psi	Action lb in/in.	Curvature $x10^{-4}$ in.$^{-1}$	Actual deflection of Target 1 in.	Deflections relative to target 1 ($x10^{-4}$ in.) 2	3	4	5	6
X13	.9414	572.3	4.701	.160	-332	37	-163	-443	-70
		1158.5	9.038	.324	-599	49	-129	-761	-37
		1745.7	13.923	.493	-964	56	-212	-1111	16
		1189.9	9.565	.342	-654	6	-201	-862	-82
		603.7	4.888	.184	-289	30	-170	-504	-38
		0.0	-0.125	.111	57	60	-106	-86	-48
		579.7	4.843	.170	-300	-12	-128	-495	-55
		1167.0	9.208	.337	-593	45	-127	-752	44
		1752.7	13.701	.506	-917	74	-135	-1059	55
X14	.9727	272.3	3.777	.168	-288	-7	-22	-317	-93
		460.9	7.857	.346	-532	60	-6	-581	-17
		619.2	11.805	.520	-805	73	6	-846	19
		443.3	9.843	.468	-652	33	11	-738	11
		231.8	8.055	.370	-569	31	83	-530	8
		0.0	4.402	.181	-364	-79	144	-250	-25
		211.0	6.232	.266	-454	-22	85	-420	-16
		424.1	9.124	.399	-642	54	43	-630	-13
		619.8	12.267	.541	-828	107	57	-832	49
X15	1.0060	185.9	3.395	.168	-311	-92	-55	-307	-111
		315.4	8.340	.339	-660	-77	-57	-651	-86
		432.1	12.517	.507	-981	-119	-128	-966	-42
		308.5	10.930	.460	-844	-82	-131	-868	-63
		163.0	9.628	.370	-729	-22	-5	-669	4
		-1.0	4.392	.244	-303	79	42	-229	80
		145.4	5.586	.228	-428	6	8	-366	7
		292.5	9.340	.385	-728	-66	-47	-698	-49
		436.4	13.121	.524	-987	-73	-107	-1002	-19
X16	1.0636	111.3	3.694	.160	-290	-92	20	-432	-308
		193.9	7.961	.323	-624	-147	40	-755	-358
		269.6	13.256	.493	-1015	-182	220	-1049	-348
		190.2	11.361	.433	-842	-139	148	-959	-339
		96.9	9.017	.303	-680	-134	32	-856	-373
		0.0	2.958	.103	-165	28	115	-201	-23
		87.9	5.770	.214	-434	-72	135	-438	-145
		180.6	9.763	.360	-762	-184	115	-845	-333
		269.1	13.666	.509	-1040	-157	303	-977	-244
X17	1.1161	648.5	3.833	.167	-280	8	25	-268	-25
		1333.3	9.076	.422	-626	-86	48	-846	-292
		1999.9	11.916	.473	-966	-276	-277	-1295	-537
		1358.8	8.680	.330	-688	-108	-261	-935	-377
		699.6	4.604	.176	-362	-47	-193	-554	-266
		9.5	0.302	.009	-11	58	-116	-105	-87
		660.2	4.156	.164	-308	-11	-192	-518	-252
		1339.7	7.892	.318	-664	-143	-422	-981	-452
		2009.0	12.371	.472	-981	-225	-400	-1440	-654
X18	1.2121	351.1	3.552	.171	-274	-25	-20	-273	-26
		560.0	6.864	.346	-522	-65	-52	-554	-58
		732.2	10.895	.514	-870	-174	-59	-871	-111
		525.9	9.437	.455	-764	-173	-80	-799	-155
		276.0	7.878	.360	-630	-122	-42	-634	-95
		0.0	3.593	.159	-274	-35	17	-291	-77
		248.3	6.038	.243	-501	-90	-50	-478	-79
		500.3	8.472	.389	-631	-63	-59	-704	-108
		750.3	11.177	.532	-899	-195	-153	-976	-183
X19	1.3090	211.5	3.694	.175	-207	26	-27	-298	55
		358.6	8.472	.335	-611	-64	-66	-720	-92
		496.6	12.809	.506	-830	39	23	-946	75
		352.7	12.197	.452	-860	-93	-78	-995	-26
		187.5	10.347	.346	-737	-85	-88	-869	-59
		0.0	3.680	.113	-218	29	-68	-334	-5
		164.6	5.798	.215	-358	52	-78	-476	28
		333.59	9.437	.375	-648	-21	-73	-768	-20
		495.5	13.961	.511	-966	-45	-93	-1144	-61
X20	1.4161	152.4	5.177	.161	-390	39	-27	-362	-25
		269.6	9.760	.336	-704	103	90	-584	42
		381.0	14.288	.505	-1032	87	118	-907	32
		269.1	12.725	.446	-904	131	97	-805	19
		141.2	8.14583	.294	-598	56	18	-587	-98
		0.5	2.725	.068	-175	133	-137	-307	-175
		123.0	5.381	.194	-410	61	-87	-473	-190
		252.0	10.222	.359	-765	68	13	-706	-79
		377.2	14.44791	.512	-1060	93	113	-930	-25
X21	1.4838	856.9	5.770	.159	-443	-93	84	-419	-53
		1689.2	9.923	.318	-768	-186	-10	-830	-142
		2485.4	14.315	.478	-1125	-253	-107	-1212	-191
		1702.0	10.170	.340	-770	-177	-2	-858	-148
		872.3	6.166	.183	-437	-83	28	-514	-71
		0.0	1.194	.110	-57	-3	148	-40	5
		827.5	5.850	.165	-440	-63	-12	-501	-122
		1665.3	10.065	.321	-755	-183	-147	-991	-263
		2509.9	14.656	.482	-1131	-239	-278	-1390	-304
X22	1.5908	365.0	2.680	.202	-192	-9	111	-123	40
		615.4	6.788	.379	-477	1	141	-399	61
		833.9	11.673	.557	-757	161	179	-639	230
		595.7	10.562	.496	-672	166	165	-563	241
		314.9	8.361	.388	-502	206	137	-413	235
		0.0	4.125	.173	-202	162	96	-173	180
		280.8	5.329	.268	-352	106	136	-257	75
		565.9	8.892	.422	-588	114	142	-482	165
		841.9	12.354	.568	-812	171	156	-681	245
X23	1.6918	280.8	3.399	.174	-230	30	20	-245	-21
		454.5	7.385	.344	-522	50	0	-572	-111
		609.1	12.416	.513	-820	113	-31	-945	-36
		435.3	11.006	.462	-755	82	-40	-822	-26
		224.8	9.222	.361	-645	45	-20	-688	-35
		0.0	3.718	.125	-269	-2	46	-240	9
		201.9	5.534	.208	-420	0	6	-394	-40
		414.5	8.739	.373	-604	75	-5	-620	-1
		615.4	12.770	.529	-872	101	-53	-946	-6
X24	1.8393	172.1	4.680	.140	-290	55	-65	-418	-58
		309.0	8.753	.333	-563	20	-194	-843	-117
		437.5	13.190	.497	-890	20	-325	-1233	-142
		311.7	12.510	.444	-851	30	-290	-1160	-159
		164.1	9.076	.410	-661	-65	-275	-907	-182
		0.0	3.406	.090	-291	-104	-163	-400	-134
		144.9	5.628	.200	-401	-32	-185	-554	-72
		294.6	9.493	.358	-648	18	-226	-878	-110
		440.1	13.506	.505	-916	18	-294	-1228	-122

TABLE B4 CONTINUED

Y13	0.9111	22.3	1.829	.083	-342	-5	-19	-349	31
		64.4	6.715	.245	-732	-27	-27	-756	-7
		102.3	11.874	.410	-1103	11	-23	-1051	60
		70.3	8.131	.288	-818	-3	17	-755	83
		36.2	3.826	.153	-470	-57	-30	-447	-23
		0.0	-0.170	.012	-24	15	12	-8	33
		34.1	3.413	.138	-413	0	-24	-373	21
		67.1	7.541	.268	-746	-4	-11	-713	49
		100.7	11.826	.413	-1092	45	41	-1069	70
Y14	.09757	44.7	5.059	.160	-377	-40	-15	-404	-50
		85.2	10.079	.323	-745	-73	10	-782	-88
		124.1	15.315	.488	-1082	-5	30	-1128	-34
		85.2	10.614	.345	-767	-40	11	-797	-42
		43.6	5.923	.183	-432	-30	9	-455	-47
		0.0	0.125	.013	-12	-28	-30	-65	-60
		40.5	5.013	.165	-400	-75	-25	-407	-70
		83.1	10.354	.325	-752	-50	1	-796	-65
		125.2	16.267	.489	-1364	-279	-209	-1375	-305
Y15	1.0060	42.6	4.694	.165	-340	13	52	-298	11
		81.0	9.927	.326	-705	17	86	-668	10
		115.6	14.989	.490	-1066	-16	149	-1014	24
		79.9	10.468	.344	-740	15	113	-693	21
		39.9	5.010	.173	-365	17	40	-327	2
		0.0	0.149	.018	13	53	21	10	15
		38.3	4.913	.158	-353	6	32	-338	-5
		77.8	9.836	.330	-710	7	121	-637	11
		116.7	15.395	.502	-1122	15	155	-992	36
Y16	1.0777	44.2	5.131	.168	-360	32	54	-301	70
		86.3	10.086	.333	-675	117	56	-651	80
		127.3	15.187	.497	-1005	170	59	-1000	135
		87.3	9.027	.368	-465	129	54	-685	117
		43.6	5.812	.197	-385	56	30	-386	46
		0.0	0.663	.019	-40	4	-6	-60	-7
		42.6	5.142	.176	-371	44	4	-341	9
		85.2	10.003	.345	-647	127	44	-647	122
		128.4	15.527	.507	-1022	214	24	-1035	120
Y17	1.0989	52.2	4.881	.162	-354	2	-27	-353	17
		99.1	10.239	.325	-747	-17	0	-728	16
		142.2	15.211	.484	-1066	55	-38	-1100	32
		99.1	11.145	.347	-801	53	-60	-798	19
		49.0	5.486	.181	-368	40	-10	-396	22
		0.0	0.038	.021	29	45	-3	2	31
		47.9	4.989	.165	-346	-13	-29	-398	-9
		94.8	9,687	.316	-693	-13	-46	-750	-37
		143.8	15.361	.491	-1061	77	-50	-1117	41
Y18	1.2121	51.1	5.777	.165	-464	-37	9	-403	-42
		98.5	10.746	.324	-809	-90	-1	-820	-72
		142.2	16.038	.483	-1201	-114	-19	-1226	-102
		99.1	11.812	.356	-883	-76	-3	-904	-93
		50.6	6.097	.193	-495	-96	-63	-527	-129
		0.0	0.593	.021	-37	-35	-13	-87	-29
		47.4	5.666	.169	-429	-53	-8	-452	-69
		96.9	11.076	.333	-811	-66	-1	-852	-69
		155.4	16.309	.493	-1213	-104	-15	-1258	-126
Y19	1.282	46.8	4.833	.167	-317	36	16	-339	28
		86.3	9.430	.335	-631	102	-26	-639	100
		126.2	14.138	.505	-935	149	26	-931	165
		86.3	9.513	.355	-653	121	23	-605	80
		44.7	5.055	.180	-336	64	-9	-335	59
		0.0	0.416	.012	-17	28	-19	-41	-5
		41.5	4.399	.159	-308	4	-24	-332	7
		84.1	9.444	.330	-633	76	-4	-647	88
		125.7	14.475	.507	-933	191	15	-966	165
Y20	1.4474	55.4	4.885	.170	-274	120	42	-291	115
		106.0	10.017	.335	-577	219	23	-636	217
		157.2	15.267	.506	-890	313	47	-941	375
		107.6	10.996	.366	-633	242	60	-647	305
		54.8	5.451	.196	-300	166	62	-318	106
		0.0	0.222	.019	30	25	72	17	61
		51.1	5.131	.173	-263	147	54	-303	145
		105.5	10.472	.343	-604	222	52	-632	270
		157.7	15.510	.509	-902	307	27	-982	365
Y21	1.4908	61.8	4.760	.170	-328	12	-40	-360	23
		115.1	10.437	.334	-713	48	-44	-768	40
		168.9	15.659	.496	-1102	77	-57	-1118	50
		117.2	11.034	.357	-751	70	-27	-784	65
		59.6	5.996	.184	-432	-20	-35	-460	-2
		0.0	0.614	.012	-33	-10	-8	-72	-15
		57.5	5.482	.172	-370	37	-1	-395	13
		114.0	10.364	.346	-718	32	-26	-740	63
		169.9	15.312	.509	-1086	57	-137	-1120	78
Y22	1.6696	67.1	4.451	.160	-341	27	-173	-357	32
		128.9	9.437	.326	-657	97	-195	-715	72
		189.7	14.503	.491	-1040	87	-214	-1083	88
		131.0	10.302	.348	-724	109	-210	-769	82
		67.1	5.336	.188	-397	57	-234	-425	70
		0.0	-0.430	.016	20	35	-140	15	51
		63.9	5.069	.166	-387	62	-180	-373	58
		126.8	9.527	.332	-675	113	-218	-702	95
		189.7	14.756	.497	-1039	142	-250	-1080	120
Y23	1.6080	59.6	5.197	.165	-373	5	5	-360	21
		112.4	9.979	.330	-707	-3	22	-700	41
		163.6	15.152	.494	-1077	27	29	-1054	46
		111.9	10.701	.354	-778	-15	-13	-775	4
		57.0	5.486	.180	-402	-12	-23	-400	11
		0.0	0.218	.008	-27	-25	-28	-38	-14
		53.8	4.913	.160	-367	-40	-28	-374	1
		109.7	9.999	.336	-708	0	4	-717	26
		173.1	15.899	.531	-1133	30	7	-1115	46
Y24	1.9484	61.2	4.989	.164	-352	15	40	-320	38
		121.5	10.204	.330	-754	-25	135	-655	11
		182.7	14.805	.494	-1082	-66	228	-947	44
		124.1	10.746	.357	-786	-35	208	-635	80
		62.8	6.086	.196	-430	35	131	-330	67
		0.0	0.239	.015	0	50	22	35	67
		59.6	5.229	.174	-370	19	120	-285	57
		121.5	10.163	.341	-728	4	200	-604	59
		182.7	14.847	.502	-1087	-34	270	-894	78

TABLE B4 DATA FROM PROTOTYPE FLEXURE TESTS CONTINUED - ACTION H

Elements under action H							Deflections relative to Target 1 ($\times10^{-4}$ in)							
Label	Modulus $\times10^{6}$ psi	Action lb in/in	Curvature $\times 10^{-4}$ in^{-1} k_x	k_y	k_{xy}	Actual deflection of target 1 (in)	2	3	4	5	6	7	8	9
T1	1.3474	-16.25345	0.09373	-0.08768	-4.41723	.461	515	1013	544	543	591	1067	600	132
		-31.44109	0.14210	-0.13908	-8.92063	.906	990	1993	1058	1048	1095	2091	1132	150
		-47.16186	0.02116	-0.06954	-13.31292	1.352	1461	2962	1551	1555	1567	3081	1647	172
		-33.03979	-0.03023	-0.01209	-12.55328	1.273	1372	2761	1457	1413	1413	2852	1500	77
		-17.18602	0.0	-0.22676	-11.46258	1.139	1218	2475	1293	1253	1260	2557	1310	-23
		0.0	-0.02116	0.13303	-9.23129	.895	1037	2058	1038	1028	1066	2071	1084	58
		-15.45409	0.00302	0.03930	-10.12471	.994	1141	2304	1162	1188	1230	2317	1255	156
		-31.44109	-0.19048	0.26304	-11.40362	1.036	1272	2552	1323	1318	1363	2642	1464	165
		-46.76196	-0.06652	-0.16629	-13.34240	1.366	1502	2957	1590	1548	1600	3106	1677	179
T2	1.2717	19.05116	0.06652	0.16629	2.36054	.388	141	340	227	123	23	445	98	-256
		31.30786	0.13001	-0.16931	9.04081	.896	929	1912	970	977	873	1985	947	-90
		49.42647	0.03930	-0.25094	13.50793	1.349	1439	2940	1480	1510	1406	2982	1479	-35
		34.10559	-0.04233	0.02116	12.63038	1.258	1337	2717	1379	1371	1280	2765	1315	-88
		17.98535	-0.06047	-0.09675	11.28344	1.111	1169	2388	1207	1206	1105	2450	1147	-138
		0.0	0.13605	-0.25397	8.01587	.782	879	1805	896	976	915	1845	975	115
		16.38667	-0.04837	-0.08466	8.99773	.876	910	1876	946	922	816	1901	856	-191
		33.17302	0.05745	-0.22373	10.72108	1.056	1114	2275	1142	1153	1030	2322	1089	-131
		49.55968	0.22676	-0.22676	13.54421	1.250	1449	2940	1481	1483	1365	2965	1447	-68
T3	1.1808	-21.71567	-0.04233	-0.07861	-4.73242	.438	445	920	410	335	295	800	256	-367
		-38.76846	0.34769	0.03930	-9.22448	.884	936	1913	878	802	785	1778	693	-377
		-56.89707	0.15722	-0.08768	-13.58956	1.329	1440	2870	1345	1258	1250	2681	1128	-442
		-39.43459	0.13605	-0.25397	-12.68027	1.228	1350	2660	1266	1176	1177	2513	1050	-419
		-67.29486	0.06652	-0.06047	-10.76417	1.052	1112	2247	1027	982	972	2105	873	-395
		-0.93257	-0.20559	0.06652	-8.46258	.791	944	1875	925	918	905	1820	916	-37
		-18.65149	0.31141	-0.39607	-9.20181	.893	936	1940	890	845	865	1785	741	-333
		-37.56944	0.27211	-0.18141	-11.12244	1.075	1165	2360	1104	1048	1033	2204	922	-341
		-56.48738	0.19955	0.16327	-13.50340	1.326	1415	2864	1311	1246	1222	2655	1114	-436
T4	1.1292	61.94960	-0.40514	0.45654	4.63039	.464	366	909	486	432	385	960	410	-173
		115.50606	-0.13001	-0.41119	8.96144	.907	905	1793	943	886	783	1895	852	-264
		166.39795	-0.02116	-0.69237	13.22902	1.350	1352	2676	1418	1313	1175	2810	1315	-348
		116.43864	-0.05442	-0.49887	10.95238	1.119	1052	2138	1108	1021	895	2266	1000	-426
		59.81801	-0.03930	-0.33862	7.23129	.729	713	1414	768	682	597	1522	685	-253
		0.0	0.18745	0.25094	2.07710	.236	144	386	196	160	175	452	220	-78
		55.95448	-0.16024	-0.08768	5.55102	.567	561	1135	587	564	526	1187	544	-126
		112.70834	0.13001	-0.26909	9.74149	.995	999	1978	1055	962	892	2105	992	-213
		167.59692	-0.19652	-0.76795	13.72789	1.410	1452	2814	1523	1400	1283	2952	1417	-288
T5	1.0676	17.05278	0.03326	0.07861	4.38549	.436	378	777	395	308	233	820	245	-337
		31.84076	0.06652	0.09373	8.45124	.876	803	1632	786	721	662	1689	642	-406
		47.82776	-0.20559	-0.06047	12.80045	1.314	1259	2521	1256	1176	1087	2623	1068	-501
		34.23882	0.16327	0.11791	11.87981	1.140	1182	2444	1157	1156	1119	2494	1099	-301
		17.58569	-0.06047	0.17536	10.27891	1.040	988	2043	969	940	908	2105	863	-385
		-0.26645	0.03023	0.24792	6.41496	.657	623	1289	625	595	570	1335	548	-205
		14.12185	-0.29025	0.02721	7.62358	.716	713	1462	745	675	588	1530	585	-370
		32.10722	0.17536	0.36583	9.68934	1.014	953	1956	951	893	895	2036	872	-281
		48.22745	-0.58050	-0.08163	13.15873	1.355	1423	2825	1420	1428	1438	2865	1380	-113
T6	1.0141	-17.18602	0.13908	0.09373	-2.17460	.401	208	480	262	243	207	495	256	16
		-31.30786	0.29630	0.11489	-8.79591	.865	789	1623	823	651	502	1659	516	-597
		-47.29486	0.26002	0.31444	-13.16326	1.320	1303	2643	1337	1177	1038	2673	1078	-489
		-32.64011	0.30234	0.17536	-12.40589	1.228	1153	2371	1181	988	834	2396	848	-704
		-16.65311	0.41119	0.34769	-11.04308	1.059	935	1926	952	665	438	1950	448	-994
		0.26645	0.27816	0.45049	-8.15192	.806	846	1693	865	773	728	1739	766	-163
		-15.45409	0.26002	0.35979	-9.21315	.871	748	1502	763	480	232	1561	258	-1000
		-30.90919	0.56538	0.14815	-10.60030	1.049	973	1985	992	801	638	2016	611	-674
		-46.76196	0.67422	0.06652	-13.09236	1.324	1276	2533	1343	1113	1000	2623	1000	-558
							1728	3497	1760	1601	1478	3532	1472	-533
T7	0.9535	20.25020	0.03326	-0.11187	4.54422	.450	497	998	504	504	491	1003	514	-3
		36.77008	0.17838	-0.13909	8.95011	.897	978	1995	978	969	963	1970	998	-22
		54.48901	0.10884	-0.18141	13.31972	1.347	1431	2889	1466	1453	1412	2942	1479	-43
		38.10233	0.31444	-0.29327	12.66666	1.246	1273	2560	1292	1202	1049	2624	1135	-402
		20.25020	0.06954	-0.37491	11.46938	1.100	1130	2259	1136	1021	854	2273	909	-526
		-0.13322	0.00302	-0.32351	8.98639	.849	989	1966	932	960	924	1886	903	-111
		18.11859	0.23280	-0.37491	9.91610	.960	1048	2152	1034	1032	987	2082	1000	-139
		36.23720	0.05442	-0.17234	11.27437	1.118	1212	2436	1216	1205	1155	2437	1184	-99
		54.08932	0.32048	-0.16931	13.61224	1.368	1418	2908	1467	1426	1358	2958	1441	-137
T8	0.9141	-57.15352	0.74981	0.33258	-4.24943	.536	400	921	415	393	413	901	382	-52
		-105.38095	-0.63794	0.34936	-8.42630	.883	978	1800	804	810	753	1716	754	-200
		-148.94543	-0.37491	0.53212	-12.48299	1.353	1348	2663	1236	1228	1191	2569	1179	-273
		-103.64903	-0.50491	0.73772	-10.33559	1.083	1116	2156	968	958	899	2068	888	-334
		-53.55643	-0.46258	0.37188	-6.94559	.698	705	1352	595	558	487	1294	469	-417
		0.0	-0.29630	0.10280	-2.26757	.235	305	565	268	327	331	556	339	121
		-49.69290	-0.38537	0.35676	-5.54989	.525	536	1006	454	427	363	966	353	-255
		-100.31841	-0.45956	0.58352	-9.91836	.939	967	1872	840	851	795	1802	783	-259
		-150.01111	-0.55329	0.75293	-12.79591	1.348	1398	2714	1241	1237	1185	2610	1172	-319

TABLE B4 CONTINUED

T9	0.8755	14.25507	-0.35072	0.34837	4.56462	.425	323	666	386	234	115	789	134	-558
		28.24370	0.01914	-0.15419	9.02040	.873	782	1602	876	719	523	1799	636	-577
		43.69778	-0.00605	-0.44142	13.34653	1.321	1252	2512	1364	1203	984	2783	1144	-591
		30.37529	-0.09977	-0.28118	12.70748	1.237	1192	2382	1287	1103	884	2582	999	-640
		15.98698	0.07559	-0.39607	11.39035	1.088	1046	2084	1076	909	692	2205	774	-730
		0.93257	0.06652	-0.07861	8.81632	.833	944	1862	933	901	863	1884	868	-142
		13.45572	0.41723	-0.35374	9.55555	.924	954	1845	953	828	698	1942	782	-427
		28.90981	0.08163	-0.24490	11.14512	1.067	1080	2147	1161	1021	853	2334	970	-434
		43.56456	-0.22676	-0.24490	13.73015	1.365	1296	2637	1458	1295	1092	2922	1256	-496
T10	0.8343	-19.45084	0.25094	-0.07559	-4.46938	.448	450	940	441	401	397	871	352	-160
		-33.70590	-0.06954	0.03930	-8.95691	.891	925	1896	871	859	820	1784	778	-270
		-48.36066	0.18141	0.04535	-13.37415	1.335	1365	2837	1320	1284	1220	2681	1160	-380
		-33.83913	0.02721	0.32653	-12.71201	1.252	1300	2660	1233	1166	1120	2523	1086	-423
		-17.31924	0.07559	0.25699	-11.43083	1.122	1142	2395	1097	1063	1003	2271	978	-375
		0.26645	-0.13001	0.29630	-8.65759	.857	1005	2025	993	1056	1092	2008	1127	215
		-15.72054	0.04837	0.23895	-9.66666	.949	1030	2139	1015	1033	1038	2081	1044	-43
		-32.37366	-0.21769	-0.09070	-11.01133	1.101	1208	2452	1169	1207	1207	2349	1182	-55
		-48.49388	0.00302	-0.15117	-13.70748	1.371	1440	2972	1395	1397	1389	2823	1327	-250
T11	0.7959	22.51501	-0.29932	-0.18141	4.48753	.452	538	1020	509	528	536	977	494	18
		37.96910	-0.42933	-0.26606	9.00690	.900	1043	2015	996	1021	1018	1937	953	-20
		54.62224	-0.37491	-0.26606	13.32879	1.350	1531	2995	1463	1498	1513	2874	1433	-9
		37.56944	-0.36291	-0.35374	12.58505	1.256	1381	2713	1320	1306	1283	2610	1221	-227
		19.45084	-0.33560	-0.26304	11.50566	1.125	1301	2515	1219	1214	1198	2393	1108	-166
		-0.26645	-0.23280	-0.05140	9.40816	.910	1166	2207	1096	1096	1218	2092	1128	150
		18.11859	-0.26002	-0.14210	10.18140	1.007	1152	2303	1110	1149	1181	2200	1126	13
		35.70428	-0.59259	-0.09373	11.48072	1.143	1304	2577	1284	1278	1344	2496	1269	10
		53.82288	-0.45654	0.36047	13.36280	1.352	1497	2963	1454	1459	1491	2868	1391	-62
T12	0.7575	-58.35254	-0.38095	0.41723	-4.20408	.432	464	847	368	375	346	797	338	-170
		-106.57999	-0.40212	0.22373	-8.47618	.879	920	1826	826	823	765	1664	740	-248
		-150.94385	-0.37793	0.33862	-12.59410	1.319	1362	2710	1238	1218	1187	2514	1142	-330
		-108.94482	-0.34165	0.52910	-10.72562	1.100	1120	2197	960	881	805	1971	741	-562
		-54.48901	0.19141	0.19955	-7.00690	.598	712	1389	589	500	425	1195	304	-506
		-0.13322	-0.22071	0.56840	-2.03855	.215	255	490	183	200	215	409	230	0
		-50.09258	-0.51701	0.63492	-5.00907	.519	525	1015	443	400	343	924	388	-270
		-100.45164	-0.00302	0.50491	-9.02434	.938	948	1953	861	840	828	1777	797	-250
		-150.94385	-0.45654	0.43235	-13.03627	1.362	1430	2795	1283	1252	1217	2604	1168	-350
T13	0.7182	-15.18764	0.62910	0.00302	-4.47619	.404	355	797	378	260	177	757	142	-420
		-27.97723	0.20257	-0.11489	-9.03954	.881	896	1819	899	775	714	1754	682	-413
		-40.90005	0.17838	-0.25699	-13.34920	1.327	1345	2752	1332	1240	1166	2662	1105	-473
		-28.24370	0.07861	-0.20257	-12.69387	1.234	1269	2537	1233	1079	963	2421	896	-640
		-14.39930	0.36281	0.05442	-11.30159	1.087	1039	2175	1043	873	735	2105	705	-704
		0.26645	0.07256	0.19048	-8.51474	.809	857	1758	920	843	745	1820	821	-177
		-13.05604	-0.04233	-0.26909	-9.47619	.893	899	1800	954	790	655	1852	685	-527
		-26.77821	0.33862	0.06652	-10.75963	1.152	1047	2160	1072	953	845	2150	840	-435
		-41.03329	0.30234	-0.19652	-13.59963	1.342	1430	2848	1415	1286	1238	2758	1168	-391
T14	0.6697	16.38667	0.16629	0.00302	4.66439	.465	570	1147	553	609	661	1116	662	206
		31.04141	0.02721	-0.23593	9.07739	.911	1052	2142	1020	1138	1175	2085	1172	224
		46.76196	0.22373	-0.65608	13.61224	1.360	1527	3117	1507	1615	1625	3054	1642	168
		32.64011	0.29025	-0.21769	12.81632	1.279	1464	2908	1413	1467	1483	2853	1488	109
		17.05278	0.19141	0.03628	11.87301	1.169	1337	2717	1310	1381	1422	2670	1411	151
		0.0	0.02419	0.05140	10.14512	.996	1277	2562	1242	1379	1505	2493	1467	521
		14.92119	0.55933	0.26002	11.01133	1.077	1305	2631	1249	1339	1435	2554	1412	329
		31.17464	0.24490	-0.15442	12.77709	1.202	1419	2854	1382	1499	1546	2796	1542	324
		46.76196	0.35963	-0.69737	13.77097	1.387	1610	3162	1532	1634	1570	3107	1674	216
T15	0.6313	-19.45084	-0.23327	-0.14815	-4.46938	.454	523	968	514	497	488	983	495	-20
		-33.57269	-0.05140	0.28466	-8.93423	.897	978	1908	990	967	903	1982	930	-50
		-47.82776	-0.81633	-0.66213	-13.93673	1.447	1444	2817	1476	1404	1332	2924	1381	-361
		-33.83913	0.11791	0.07256	-12.42630	1.255	1312	2620	1358	1290	1211	2709	1252	-151
		-18.25182	0.01814	0.21769	-11.14058	1.116	1192	2351	1222	1160	1105	2424	1157	-108
		0.0	0.58957	0.32540	-8.46712	.825	924	1924	950	932	933	1940	985	130
		-15.98698	-0.17838	0.28466	-9.18367	.936	1044	1955	1047	1024	1010	2122	1042	27
		-32.24045	0.13605	0.11791	-10.82569	1.095	1150	2315	1202	1162	1088	2415	1138	-75
		-47.69459	0.15722	0.13001	-13.47618	1.365	1445	2863	1490	1417	1333	2960	1375	-120
T16	0.5848	53.55643	0.19350	0.68330	4.23829	.448	454	960	459	450	512	949	463	60
		99.73551	0.22373	1.16704	8.38549	.851	912	1925	917	873	1005	1847	906	74
		142.81714	0.06818	1.25775	12.50793	1.330	1342	2836	1311	1276	1397	2695	1301	15
		100.38454	0.46258	0.30703	10.44897	1.104	1130	2353	1106	1061	1162	2247	1089	-8
		51.95773	0.25397	0.52608	7.14059	.741	754	1576	746	736	777	1553	739	-20
		0.0	0.29932	-0.02721	2.70975	.270	314	611	315	312	341	658	378	74
		48.09421	0.39909	0.55329	5.42176	.573	579	1249	582	573	624	1197	610	55
		96.45483	0.46863	1.03099	9.11791	.975	990	2076	971	960	1049	1993	968	68
		145.48169	0.47075	1.36961	12.93650	1.389	1416	2962	1356	1329	1466	2802	1351	59

TABLE C1 DETAILS OF MODEL ELEMENTS

Action applied to element	Type of fastening*	Grading Modulus mean $\times 10^6$ psi	Grading Modulus Coefficient of variation %	Moisture Content %	Dimensions x"	Dimensions y"	Label
Actions T_1 then T_2 then S	2 + glue	0.543	6.8	11.0	7.7	7.7	1
	3	0.646	4.8	10.8	"	"	2
	2	0.722	4.2	10.9	"	"	3
	1	0.785	3.4	11.4	"	"	4
	2 + glue	0.840	3.0	11.0	"	"	5
	3	0.878	2.9	10.8	"	"	6
	2	0.917	2.5	10.8	"	"	7
	1	0.952	2.7	10.7	"	"	8
	2 + glue	0.989	2.6	10.8	"	"	9
	3	1.022	2.6	10.7	"	"	10
	2	1.054	2.3	10.9	"	"	11
	1	1.095	2.4	10.9	"	"	12
	2 + glue	1.128	2.5	11.2	"	"	13
	3	1.172	2.8	11.0	"	"	14
	2	1.213	3.0	11.0	"	"	15
	1	1.258	2.4	11.1	"	"	16
	2 + glue	1.309	2.3	11.0	"	"	17
	3	1.371	2.9	11.1	"	"	18
	2	1.425	2.5	10.6	"	"	19
	1	1.469	2.1	10.7	"	"	20
	2 + glue	1.534	2.5	10.9	"	"	21
	3	1.605	2.5	10.8	"	"	22
	2	1.681	2.7	10.2	"	"	23
	1	1.798	2.5	10.8	"	"	24
Bending Action M_1	2 + glue	0.545	3.5	10.5	12	1.4	1
	3	0.746	4.6	11.1	"	"	2A
	2	0.848	5.1	10.9	"	"	2B
	1	0.883	3.0	11.0	"	"	3
	2 + glue	0.952	1.5	11.3	"	"	4A
	3	0.992	3.4	10.9	"	"	4B
	2	1.013	3.3	11.1	"	"	5
	1	1.055	3.0	11.1	"	"	6A
	2 + glue	1.097	2.3	11.1	"	"	6B
	3	1.118	3.0	11.2	"	"	7
	2	1.144	1.5	10.8	"	"	8A
	1	1.169	1.4	10.7	"	"	8B
	2 + glue	1.199	1.3	11.1	"	"	9
	3	1.248	1.2	10.8	"	"	10A
	2	1.295	1.1	10.9	"	"	10B
	1	1.331	1.8	11.2	"	"	11
	2 + glue	1.377	1.7	11.2	"	"	12A
	3	1.419	2.6	10.5	"	"	12B
	2	1.464	1.6	11.8	"	"	13
	1	1.545	1.4	11.2	"	"	14A
	2 + glue	1.588	1.1	10.8	"	"	14B
	3	1.638	1.2	10.8	"	"	15
	2	1.703	1.4	10.9	"	"	16A
	1	1.748	1.9	10.8	"	"	16B
Bending action M_2	2 + glue	0.564	4.5	11.1	1.4	12	1A
	3	0.730	2.4	11.1	"	"	1B
	2	0.858	3.0	11.1	"	"	2
	1	0.882	4.2	10.9	"	"	3A
	2 + glue	0.933	2.0	11.0	"	"	3B
	3	1.000	3.2	11.0	"	"	4
	2	1.022	3.6	11.1	"	"	5A
	1	1.033	2.5	10.9	"	"	5B
	2 + glue	1.092	1.5	11.2	"	"	6
	3	1.117	2.2	11.1	"	"	7A
	2	1.107	3.8	10.9	"	"	7B
	1	1.172	2.0	10.6	"	"	8
	2 + glue	1.205	1.4	11.0	"	"	9A
	3	1.230	1.0	10.9	"	"	9B
	2	1.265	1.4	10.8	"	"	10
	1	1.342	1.0	10.8	"	"	11A
	2 + glue	1.358	1.1	10.8	"	"	11B
	3	1.417	1.5	10.7	"	"	12
	2	1.492	1.6	10.8	"	"	13A
	1	1.523	1.1	10.9	"	"	13B
	2 + glue	1.603	1.6	10.8	"	"	14
	3	1.653	1.1	10.9	"	"	15A
	2	1.673	1.1	10.8	"	"	15B
	1	1.770	1.8	10.8	"	"	16
Torsional action H	2 + glue	0.658	9.3	11.1	11.9	11.9	1
	3	0.812	5.3	11.1	"	"	2
	2	0.907	3.9	10.9	"	"	3
	1	0.977	3.0	10.9	"	"	4
	2 + glue	1.028	2.8	11.2	"	"	5
	3	1.078	2.9	11.0	"	"	6
	2	1.123	2.8	10.9	"	"	7
	1	1.169	3.3	10.9	"	"	8
	2 + glue	1.215	3.1	10.9	"	"	9
	3	1.278	3.6	11.0	"	"	10
	2	1.334	3.2	10.9	"	"	11
	1	1.405	3.6	11.1	"	"	12
	2 + glue	1.489	3.2	10.9	"	"	13
	3	1.579	3.2	10.9	"	"	14
	2	1.653	3.3	10.8	"	"	15
	1	1.746	3.6	10.6	"	"	16

* See Fig. 1.1

TABLE C2 DATA FROM COMPRESSION TESTS ON MODEL ELEMENTS

ACTION T_t (lb/in) AND MEAN STRAIN ε_x (microstrain) VALUES AT EACH GAUGE POSITION (see fig.6.4) ON MODEL ELEMENTS

LABEL IS 1XX

x1 & x2 ACTION	STRAIN	x3 & x4 ACTION	STRAIN	x5 & x6 ACTION	STRAIN	x7 & x8 ACTION	STRAIN	x9 & x10 ACTION	STRAIN	AVERAGED ACTIONS	& STRAINS
40.30	193.59	40.20	178.95	37.91	147.70	40.20	217.16	42.61	206.34	40.25	188.75
80.03	373.52	79.83	366.74	76.39	326.80	79.83	431.39	80.03	391.23	79.22	377.93
119.76	550.52	120.04	561.35	120.04	541.09	120.04	650.52	119.76	582.96	119.93	577.29
160.06	737.31	160.24	762.83	160.24	750.50	160.24	865.73	160.06	785.46	160.17	780.36
200.94	925.08	199.87	957.44	199.87	957.94	199.87	1078.97	199.79	981.10	200.07	980.11
240.09	1106.00	240.08	1164.76	240.08	1172.22	240.08	1298.07	240.09	1186.52	240.08	1185.51
199.79	927.98	199.87	968.14	199.72	974.57	199.87	1099.47	199.79	993.78	199.61	992.79
160.06	754.86	160.24	779.35	160.24	780.81	160.24	901.85	160.06	803.99	160.17	804.17
119.76	573.94	120.04	587.64	120.04	587.06	120.04	696.43	119.76	611.25	119.93	611.26
80.03	394.02	79.26	390.11	76.96	374.71	79.83	486.12	80.03	418.54	79.22	412.70
40.30	209.22	39.06	203.37	39.48	183.89	39.63	267.04	39.73	224.95	39.44	217.68
80.03	383.31	80.41	391.15	79.83	380.59	79.83	473.45	80.03	415.65	80.03	408.83
119.76	562.27	120.04	582.93	120.04	580.21	120.04	688.65	119.76	603.34	119.93	604.66
161.21	752.98	161.96	791.15	160.24	779.82	160.24	892.11	160.06	809.84	160.75	805.19
200.37	933.90	199.87	983.80	199.67	997.26	200.45	1113.17	199.79	1008.47	200.07	1005.32
240.09	1118.73	240.65	1197.95	240.08	1099.50	240.08	1328.36	240.09	1210.96	240.20	1191.10

LABEL IS 2XX

x1 & x2 ACTION	STRAIN	x3 & x4 ACTION	STRAIN	x5 & x6 ACTION	STRAIN	x7 & x8 ACTION	STRAIN	x9 & x10 ACTION	STRAIN	AVERAGED ACTIONS	& STRAINS
40.21	174.21	40.70	248.49	40.70	148.76	41.28	241.66	40.21	130.18	40.62	188.66
79.84	352.28	81.39	478.42	80.91	318.05	81.39	455.90	79.34	251.59	80.66	371.25
120.06	537.20	122.09	684.88	123.83	511.77	122.09	664.30	120.64	401.35	121.74	559.90
160.27	723.09	162.20	877.65	162.20	689.84	162.20	861.94	160.27	559.91	161.43	742.49
199.90	904.09	202.90	1070.41	202.32	883.54	202.90	1059.60	199.90	735.10	201.58	930.55
240.12	1086.07	241.27	1250.45	241.27	1066.42	243.01	1253.35	240.12	914.20	241.16	1114.49
199.90	919.71	202.90	1092.15	202.90	897.31	202.90	1078.18	199.90	742.95	201.70	943.06
160.27	752.38	162.20	902.09	162.20	706.54	162.20	898.12	160.27	578.54	161.43	766.34
120.06	575.27	121.51	719.10	122.67	518.55	122.09	720.95	120.06	406.28	121.28	588.03
79.84	393.27	80.81	529.25	76.74	313.08	81.39	519.30	79.84	247.70	79.73	400.52
40.21	209.33	40.70	332.58	37.79	151.63	39.53	278.19	38.47	113.56	39.34	221.06
79.84	372.76	83.14	531.22	81.39	326.79	81.39	497.80	79.34	257.47	81.12	397.21
121.22	554.75	123.83	723.01	122.09	512.68	122.09	695.46	120.64	412.14	121.97	579.61
160.27	728.91	162.20	901.10	162.78	700.53	162.20	887.25	160.27	577.54	161.55	759.07
199.90	912.85	202.90	1098.97	202.90	894.23	202.90	1084.92	199.90	746.86	201.70	945.56
240.70	1101.69	241.27	1273.89	241.27	1076.18	243.01	1274.75	240.12	924.98	241.27	1130.30

LABEL IS 3XX

x1 & x2 ACTION	STRAIN	x3 & x4 ACTION	STRAIN	x5 & x6 ACTION	STRAIN	x7 & x8 ACTION	STRAIN	x9 & x10 ACTION	STRAIN	AVERAGED ACTIONS	& STRAINS
39.96	159.58	37.29	143.89	42.75	123.35	40.44	102.83	39.96	191.14	40.48	142.15
79.92	328.88	80.30	313.10	80.30	269.14	80.30	234.00	79.92	359.31	80.15	300.92
119.88	491.30	120.17	481.53	120.17	432.63	120.17	379.03	119.88	529.61	120.05	462.62
159.85	657.65	160.03	651.85	156.30	586.35	160.03	528.79	159.85	695.31	159.61	623.93
199.81	820.09	199.89	813.37	198.74	755.77	199.89	685.44	200.97	892.93	199.86	791.51
240.35	984.48	239.18	976.86	240.91	931.11	239.75	846.02	239.77	1039.49	239.99	955.58
199.81	832.82	199.89	817.32	199.31	769.57	199.89	695.27	199.81	853.92	199.74	799.78
159.85	680.17	160.03	664.61	160.03	621.72	160.03	548.45	159.85	735.20	159.96	650.03
119.88	525.56	120.17	504.07	120.17	466.03	120.17	394.77	119.88	580.59	120.05	494.21
79.92	361.17	79.73	349.38	79.15	309.35	80.30	244.97	78.76	419.12	79.57	336.60
39.96	195.79	38.71	182.98	41.60	165.38	37.55	92.19	39.36	262.47	39.56	179.76
79.92	346.47	80.30	349.39	80.30	307.35	80.30	238.05	79.72	415.14	80.15	331.09
120.46	509.88	121.32	501.12	119.59	456.20	120.17	343.93	119.55	574.65	120.28	485.16
159.85	672.33	161.18	663.61	160.03	620.71	160.03	548.60	159.65	738.67	160.19	646.66
200.39	841.63	199.89	822.19	200.47	782.29	199.89	693.28	199.81	899.53	200.09	807.78
241.51	1005.05	239.75	983.71	239.75	959.59	239.75	849.91	240.93	1063.93	240.34	972.44

LABEL IS 4XX

x1 & x2 ACTION	STRAIN	x3 & x4 ACTION	STRAIN	x5 & x6 ACTION	STRAIN	x7 & x8 ACTION	STRAIN	x9 & x10 ACTION	STRAIN	AVERAGED ACTIONS	& STRAINS
39.94	47.05	39.25	134.20	40.41	163.34	41.57	126.28	39.94	68.49	40.22	107.87
79.87	131.24	80.25	308.54	80.25	335.63	80.25	256.49	79.87	142.33	80.10	234.95
119.81	239.91	120.09	493.95	120.09	509.93	120.09	408.24	119.81	249.51	119.97	376.09
159.74	363.29	154.15	624.90	155.88	662.72	159.92	560.90	159.74	367.46	157.89	515.95
200.26	493.54	199.76	813.98	200.97	853.78	199.76	714.67	200.26	503.29	200.19	675.97
240.19	626.74	240.18	981.57	240.18	1118.10	240.18	868.39	240.77	647.78	240.30	848.51
200.26	490.66	199.18	829.79	200.92	972.25	199.76	719.64	200.26	501.37	200.07	702.66
158.01	350.54	153.57	662.30	156.42	774.40	159.92	566.91	159.74	368.57	156.73	544.63
118.65	221.41	123.00	531.05	122.00	646.38	122.03	416.15	113.21	234.72	119.74	409.69
79.97	103.91	77.94	366.47	79.57	470.72	80.25	256.37	79.87	126.19	79.52	266.73
39.94	14.82	39.04	201.98	38.68	279.70	39.66	101.87	39.94	49.47	39.41	129.43
79.87	111.73	80.25	356.59	80.25	467.97	80.25	255.56	79.87	164.36	80.10	271.18
119.81	226.27	120.09	504.49	121.92	641.93	120.09	410.22	119.81	261.77	120.32	412.95
159.74	351.60	154.15	643.56	154.19	792.93	159.97	563.92	159.74	405.77	158.35	551.40
200.26	484.78	199.76	822.82	199.76	970.16	199.75	718.59	200.26	550.89	199.96	709.45
240.19	623.84	241.33	991.34	241.33	1143.09	240.19	874.25	240.19	690.77	240.64	864.80

TABLE C2 CONTINUED

ACTION T_i (lb/in) AND MEAN STRAIN ε_x (microstrain) VALUES AT EACH GAUGE POSITION (see fig.6.4) ON MODEL ELEMENTS

LABEL IS 5XX

x1 & x2 ACTION	x1 & x2 STRAIN	x3 & x4 ACTION	x3 & x4 STRAIN	x5 & x6 ACTION	x5 & x6 STRAIN	x7 & x8 ACTION	x7 & x8 STRAIN	x9 & x10 ACTION	x9 & x10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
39.76	77.28	40.24	164.40	41.97	189.98	40.24	116.48	39.76	78.28	40.39	125.26
80.10	187.84	79.91	319.03	81.63	349.41	79.91	244.70	80.10	181.04	80.33	256.41
119.87	297.44	120.15	463.89	120.15	500.14	120.15	379.77	119.87	286.75	120.04	385.60
161.36	421.70	159.81	607.77	160.39	652.83	159.81	516.80	160.21	403.22	160.32	520.46
199.97	540.09	200.63	750.67	200.05	801.61	200.63	656.77	199.97	517.74	200.25	653.38
240.31	670.24	240.29	886.73	240.29	949.43	240.29	801.64	239.74	637.14	240.19	789.03
199.97	547.92	200.05	754.60	200.09	812.39	200.05	672.45	199.97	521.67	200.02	661.80
160.21	432.46	158.66	614.64	159.81	665.56	159.81	534.45	159.63	411.07	159.63	531.64
119.87	308.20	120.15	492.27	118.42	519.69	120.15	404.27	119.87	300.48	119.69	404.98
80.10	191.79	79.31	350.35	76.46	362.08	79.91	264.30	80.10	191.84	79.30	272.07
38.61	80.25	39.09	194.73	37.94	206.45	39.09	135.08	39.76	92.00	38.90	141.70
81.26	190.82	79.91	338.60	79.91	364.04	79.91	260.38	80.10	193.90	80.22	269.53
119.87	302.36	120.15	478.57	122.45	524.57	120.15	396.43	119.87	301.46	120.50	400.68
160.21	424.66	159.81	617.55	159.81	661.61	159.81	531.50	160.21	415.01	159.97	530.07
199.97	545.99	200.05	756.55	203.50	821.16	200.05	669.51	199.97	530.50	200.71	664.74
239.74	672.23	240.29	897.49	240.29	955.28	240.29	808.50	239.74	645.99	240.07	795.90

LABEL IS 6XX

x1 & x2 ACTION	x1 & x2 STRAIN	x3 & x4 ACTION	x3 & x4 STRAIN	x5 & x6 ACTION	x5 & x6 STRAIN	x7 & x8 ACTION	x7 & x8 STRAIN	x9 & x10 ACTION	x9 & x10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
41.74	104.75	39.90	147.72	39.90	163.55	43.37	110.71	40.00	89.05	40.99	123.16
80.01	229.09	79.81	299.40	78.07	322.16	79.81	223.34	80.01	180.09	79.54	250.82
120.59	366.19	120.29	435.48	121.45	495.34	120.29	353.58	120.01	271.12	120.53	384.94
160.01	499.38	160.20	572.52	159.62	642.21	160.20	490.66	160.01	381.72	160.01	517.30
200.02	635.51	200.68	710.56	200.10	790.95	200.10	620.89	200.02	497.23	200.18	651.03
240.02	772.65	240.01	843.71	240.58	939.69	240.01	752.10	240.02	617.64	240.13	785.16
200.02	647.31	200.10	709.60	199.52	798.79	200.10	629.74	200.02	497.35	199.95	655.56
160.01	518.06	160.20	578.42	159.62	659.87	160.20	508.34	160.01	372.93	160.01	527.52
120.01	384.87	119.14	438.44	117.40	515.05	120.29	381.07	120.01	254.49	119.37	394.78
80.01	251.65	79.81	306.28	77.50	368.30	79.81	254.76	78.85	144.84	79.19	265.17
38.84	111.62	39.90	164.35	37.59	206.84	39.90	124.59	40.00	61.63	39.25	133.79
80.59	239.90	79.81	300.41	81.54	370.23	79.81	244.92	80.01	169.81	80.35	264.95
120.01	370.15	120.29	436.49	123.18	521.90	119.71	369.27	120.01	275.26	120.64	394.57
160.01	509.20	161.35	579.40	160.77	655.94	160.20	496.55	160.01	387.59	160.47	526.14
200.02	645.34	200.10	709.61	200.10	791.95	200.10	625.80	200.02	506.09	200.07	655.76
240.02	781.49	240.01	850.57	240.58	935.70	240.01	757.98	240.02	625.52	240.13	790.86

LABEL IS 7XX

x1 & x2 ACTION	x1 & x2 STRAIN	x3 & x4 ACTION	x3 & x4 STRAIN	x5 & x6 ACTION	x5 & x6 STRAIN	x7 & x8 ACTION	x7 & x8 STRAIN	x9 & x10 ACTION	x9 & x10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
40.02	90.92	42.82	123.23	41.03	128.22	42.24	116.60	41.76	63.52	41.59	105.70
80.05	185.76	79.45	236.76	73.27	241.73	81.53	225.35	80.05	194.33	80.16	216.90
120.65	306.12	119.78	373.83	123.25	377.72	120.93	353.66	120.07	337.03	120.94	350.23
160.10	434.34	156.23	501.13	153.92	457.01	154.49	469.22	160.10	485.72	156.97	469.49
201.28	569.43	200.21	652.91	203.21	596.98	194.42	622.94	200.12	629.69	199.25	614.40
240.15	691.82	240.13	789.06	241.29	723.28	240.13	761.11	240.15	773.70	240.37	747.79
199.54	571.45	199.05	658.87	199.63	587.24	200.21	627.95	200.12	642.53	199.71	617.60
158.94	445.21	153.92	465.99	152.76	433.64	157.39	485.30	160.10	512.23	156.62	467.80
120.07	326.79	119.78	353.32	118.04	320.04	119.78	363.56	120.07	381.56	119.55	349.96
80.05	203.47	79.85	224.08	77.54	196.74	79.85	227.43	80.05	245.92	79.47	219.53
40.02	89.93	40.50	87.98	36.45	77.36	39.93	100.05	40.02	107.81	39.39	92.63
80.05	201.49	79.85	215.23	82.17	221.21	79.85	227.37	80.05	242.17	80.39	219.49
120.07	318.91	119.78	342.51	118.62	333.77	117.78	355.69	120.07	369.23	119.66	343.82
160.10	441.26	155.07	460.98	159.23	449.23	154.49	470.23	160.09	509.26	157.31	466.20
200.12	557.54	202.52	617.64	203.21	589.21	200.21	625.96	200.12	649.32	200.63	609.73
240.15	694.81	240.13	741.03	240.13	719.41	241.29	765.03	240.15	797.39	240.37	741.53

LABEL IS 8XX

x1 & x2 ACTION	x1 & x2 STRAIN	x3 & x4 ACTION	x3 & x4 STRAIN	x5 & x6 ACTION	x5 & x6 STRAIN	x7 & x8 ACTION	x7 & x8 STRAIN	x9 & x10 ACTION	x9 & x10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
40.13	107.59	40.03	183.07	40.71	78.26	40.03	70.44	40.13	139.73	40.21	115.82
80.84	252.36	80.06	370.98	80.26	178.10	80.06	173.25	80.26	274.69	80.30	249.68
119.81	396.17	121.25	536.39	119.81	282.83	119.51	281.93	119.41	401.10	120.04	379.65
159.94	540.99	160.12	680.26	160.52	403.25	160.12	404.13	159.44	530.22	160.13	511.78
200.07	680.93	203.05	827.07	200.07	524.66	201.99	531.45	200.07	656.22	201.03	644.13
240.19	820.87	240.18	956.26	240.78	651.97	240.18	651.88	240.19	783.33	240.31	772.96
200.07	693.68	201.59	938.33	199.90	524.74	201.59	537.36	200.07	665.40	200.56	652.00
159.94	574.30	160.12	703.80	158.77	400.43	160.12	416.95	159.94	549.31	159.78	528.88
119.81	439.27	122.39	574.60	119.22	293.92	120.39	238.51	119.31	426.55	119.80	404.57
79.10	293.47	80.06	431.72	80.26	165.44	80.06	183.97	80.26	359.69	79.95	276.74
40.13	135.96	38.87	261.45	40.13	57.76	40.03	78.27	39.55	167.15	39.74	140.12
80.26	270.97	80.04	411.17	80.26	171.29	80.44	187.89	80.26	296.31	80.30	267.53
119.81	411.86	120.09	553.07	119.91	288.75	120.09	295.57	120.39	416.70	120.04	393.19
161.68	564.51	160.12	697.90	159.94	419.95	160.12	414.99	159.74	541.22	160.36	527.68
200.07	697.59	202.47	839.80	200.65	543.30	200.15	544.13	200.07	667.31	200.68	658.44
240.78	841.44	240.18	968.01	242.52	672.55	240.18	607.53	240.19	775.58	240.77	789.02

TABLE C2 CONTINUED

ACTION T_t (lb/in) AND MEAN STRAIN ε_x (microstrain) VALUES AT EACH GAUGE POSITION (see fig.6.4) ON MODEL ELEMENTS

LABEL IS 9XX

x1 & x2 ACTION	x1 & x2 STRAIN	x3 & x4 ACTION	x3 & x4 STRAIN	x5 & x6 ACTION	x5 & x6 STRAIN	x7 & x8 ACTION	x7 & x8 STRAIN	x9 & x10 ACTION	x9 & x10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
40.09	112.59	39.41	103.75	41.15	81.18	39.41	108.58	40.09	122.28	40.03	105.67
80.17	234.93	79.98	210.43	80.56	172.15	78.82	224.02	80.17	243.57	79.94	217.02
120.26	348.46	118.23	310.24	119.39	274.86	118.23	342.40	120.26	366.81	119.27	328.55
159.77	463.94	158.21	416.90	158.79	375.62	157.63	462.75	159.77	487.11	158.84	441.26
199.86	583.32	197.62	526.48	196.46	469.54	197.04	590.92	199.86	607.41	198.17	555.53
239.94	696.84	236.45	635.08	236.45	580.08	236.45	710.28	239.94	728.69	237.85	670.19
198.11	587.23	197.04	531.36	197.04	469.53	197.04	595.81	199.86	613.27	197.82	559.44
159.77	484.47	157.63	421.78	156.48	361.92	157.63	475.46	159.77	494.91	158.26	447.71
120.26	374.87	117.65	318.06	118.23	263.13	118.23	357.06	119.68	377.54	118.81	338.13
80.17	253.52	78.82	216.30	72.44	154.54	78.82	237.69	79.01	252.34	77.85	222.88
40.09	127.26	38.25	111.59	37.09	77.26	39.41	118.32	40.09	133.01	38.98	113.49
80.17	241.77	78.82	213.37	78.82	170.19	79.98	236.71	80.17	252.35	79.59	222.88
120.26	357.25	118.81	317.09	115.91	261.19	118.23	355.09	120.26	375.59	118.69	333.24
159.77	470.78	157.63	421.80	157.06	369.78	157.63	471.53	159.77	495.91	158.37	445.96
199.86	585.29	198.20	535.30	197.04	474.46	197.04	593.83	199.86	619.15	198.40	561.60
239.94	699.79	236.45	640.96	235.87	582.07	236.45	716.13	239.94	740.42	237.73	675.87

LABEL IS 10XX

x1 & x2 ACTION	x1 & x2 STRAIN	x3 & x4 ACTION	x3 & x4 STRAIN	x5 & x6 ACTION	x5 & x6 STRAIN	x7 & x8 ACTION	x7 & x8 STRAIN	x9 & x10 ACTION	x9 & x10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
40.13	132.13	40.04	92.95	41.20	117.24	39.46	152.65	42.46	96.84	40.66	118.36
80.27	272.07	80.07	200.60	80.07	219.89	78.91	295.53	80.27	181.35	79.92	234.01
120.40	408.09	119.53	276.96	118.37	328.45	118.37	437.43	120.40	271.97	119.41	344.58
159.96	539.23	157.82	395.34	158.98	440.94	157.82	568.57	160.54	367.34	159.02	462.38
200.09	671.32	197.28	514.71	197.28	553.46	197.28	697.74	200.09	458.82	198.40	579.21
240.23	796.58	236.73	635.06	237.89	674.79	236.73	823.02	240.23	553.72	238.36	696.63
200.09	686.02	197.28	526.46	197.28	561.29	197.28	708.52	200.09	456.85	198.40	587.83
159.96	568.62	157.82	412.96	158.40	450.72	157.82	591.10	159.96	359.52	158.79	476.48
120.40	446.32	117.21	288.70	117.79	334.29	118.37	467.80	120.40	263.15	118.83	360.05
80.27	315.22	78.33	177.14	77.75	218.84	78.91	339.60	80.27	168.25	79.11	243.81
40.13	171.36	38.29	65.58	36.55	104.39	39.46	193.78	38.39	69.46	38.57	120.91
80.27	297.57	78.91	170.28	78.91	219.84	78.91	322.96	80.27	169.24	79.45	235.98
120.40	425.76	121.27	290.65	117.79	330.41	118.37	455.08	120.40	265.12	119.65	353.40
159.96	552.96	158.40	400.23	160.72	458.58	157.82	564.26	159.96	362.95	159.37	471.80
200.09	676.27	197.28	507.89	197.28	563.29	197.28	711.48	200.09	460.80	198.40	583.95
240.23	798.58	238.47	633.13	236.73	677.78	237.31	835.77	240.23	556.70	238.59	700.39

LABEL IS 11XX

x1 & x2 ACTION	x1 & x2 STRAIN	x3 & x4 ACTION	x3 & x4 STRAIN	x5 & x6 ACTION	x5 & x6 STRAIN	x7 & x8 ACTION	x7 & x8 STRAIN	x9 & x10 ACTION	x9 & x10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
40.01	71.44	40.49	93.95	43.96	153.65	39.34	135.97	40.01	57.82	40.76	102.57
80.03	177.13	78.67	193.75	78.67	277.92	78.67	279.81	80.03	134.23	79.21	212.57
120.04	286.75	118.01	298.46	118.59	407.16	118.01	412.94	120.04	221.39	118.94	325.34
160.06	396.38	158.50	411.99	157.92	532.55	157.92	540.21	160.06	321.26	158.89	440.48
200.07	504.06	196.68	521.62	196.68	653.09	197.84	665.54	200.07	421.13	198.27	553.09
241.24	614.69	237.75	633.22	237.18	790.56	236.60	784.03	240.08	527.83	238.57	668.06
200.07	514.85	196.10	516.75	197.26	661.04	197.26	671.46	200.07	423.12	198.15	557.45
160.06	414.04	157.92	411.05	159.66	548.37	157.92	556.93	160.06	323.23	159.12	450.73
118.88	302.45	118.01	305.31	114.54	408.25	118.01	437.49	120.04	221.49	117.90	335.00
80.03	198.68	78.67	191.77	79.83	295.58	78.67	312.18	80.03	129.45	79.45	225.53
40.01	86.15	39.91	79.23	45.12	174.13	39.34	165.34	40.01	52.03	40.88	111.37
80.03	184.01	78.67	198.84	78.67	281.87	79.25	295.53	81.19	131.35	79.56	216.32
120.04	287.75	118.01	288.69	118.59	404.31	118.01	418.85	120.04	217.51	118.94	323.43
160.06	398.35	159.08	406.13	159.08	535.59	157.92	542.23	160.06	318.45	159.24	440.13
200.07	506.02	197.26	516.74	196.68	656.11	197.26	664.61	200.07	424.08	198.27	553.51
240.08	611.74	236.60	628.33	237.75	782.56	237.18	786.03	240.08	532.73	238.34	668.28

LABEL IS 12XX

x1 & x2 ACTION	x1 & x2 STRAIN	x3 & x4 ACTION	x3 & x4 STRAIN	x5 & x6 ACTION	x5 & x6 STRAIN	x7 & x8 ACTION	x7 & x8 STRAIN	x9 & x10 ACTION	x9 & x10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
40.15	64.57	39.47	160.47	40.63	81.15	40.63	139.03	43.06	74.40	40.79	103.92
79.72	141.83	78.94	314.16	80.10	163.39	78.94	256.49	79.72	154.55	79.48	206.11
120.45	238.69	119.41	453.17	124.80	268.12	118.41	372.00	119.87	246.66	120.39	315.73
161.18	342.41	157.88	579.46	156.46	354.25	157.88	481.63	160.02	346.49	159.09	420.85
200.17	439.32	198.51	707.71	197.35	457.02	197.35	592.23	200.17	446.31	198.71	528.52
239.74	538.19	237.99	824.23	242.63	581.34	236.82	697.95	239.74	544.17	239.38	637.17
200.17	445.21	196.77	714.60	197.35	461.93	197.35	597.16	200.17	448.29	198.36	533.44
160.02	346.35	157.30	601.06	156.72	357.22	157.53	495.33	160.02	347.51	158.39	429.50
119.87	245.55	117.83	480.66	123.64	270.11	118.41	393.58	119.87	248.55	119.92	327.72
79.72	144.73	78.36	354.37	77.20	154.62	78.94	293.95	79.72	155.72	78.79	216.68
40.15	55.72	38.31	198.70	37.73	62.61	38.31	158.65	40.15	67.61	38.93	108.66
82.63	148.67	79.52	339.65	73.94	141.46	79.94	273.15	79.72	154.70	79.95	215.53
119.87	237.72	118.41	462.02	124.22	273.04	118.41	392.73	119.87	247.48	120.16	320.65
160.02	336.57	157.39	592.43	157.99	360.15	157.88	497.52	160.02	347.49	158.74	422.83
201.33	440.32	197.35	702.94	197.58	470.75	197.35	598.12	200.17	447.30	199.18	531.87
239.74	540.17	236.82	820.33	236.82	570.58	236.82	700.90	240.32	547.12	238.11	635.82

TABLE C2 CONTINUED

ACTION T_t (lb/in) AND MEAN STRAIN ε_x (microstrain) VALUES AT EACH GAUGE POSITION (see fig.6.4) ON MODEL ELEMENTS

LABEL IS 13XX

x1 & x2 ACTION	STRAIN	x3 & x4 ACTION	STRAIN	x5 & x6 ACTION	STRAIN	x7 & x8 ACTION	STRAIN	x9 & x10 ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
40.10	62.61	42.90	133.12	41.74	139.97	39.42	91.06	40.10	60.68	40.85	97.49
80.20	133.05	78.84	239.81	79.42	264.24	78.84	189.93	80.20	138.03	79.50	193.01
119.71	210.34	118.26	351.39	119.42	394.39	118.26	288.80	119.71	216.31	119.07	292.24
159.81	292.53	158.26	461.39	157.68	512.80	157.68	384.72	159.81	302.45	158.65	390.90
199.91	369.85	197.10	564.74	198.83	637.08	197.10	493.57	199.91	395.43	198.57	489.94
240.01	467.65	235.93	669.47	239.51	749.62	236.51	578.51	240.01	496.46	237.79	590.34
199.91	380.58	197.10	569.64	192.36	635.13	197.10	483.59	199.91	396.42	197.87	493.07
159.81	294.49	157.68	469.82	157.66	524.55	157.68	389.62	159.81	305.40	158.53	396.78
119.71	208.39	117.68	366.06	118.26	407.12	118.26	297.61	119.71	216.33	118.72	299.10
80.20	127.16	78.84	258.38	77.68	283.82	78.84	200.69	80.20	134.11	79.15	200.84
40.10	50.87	35.94	129.17	39.47	159.52	39.42	100.84	40.10	54.81	38.99	99.04
80.20	124.25	80.00	254.45	81.16	280.87	78.84	197.74	82.52	139.39	80.54	199.26
120.29	205.46	118.26	356.24	120.00	401.24	118.26	291.71	120.29	217.30	119.42	294.39
159.81	288.63	157.68	464.88	157.68	513.79	157.68	386.67	159.81	303.44	158.53	391.48
199.91	375.70	197.10	573.53	197.10	634.16	197.10	482.59	199.91	393.49	198.22	491.89
240.59	464.73	235.51	678.26	236.51	752.58	236.51	560.47	240.01	484.52	238.03	592.11

LABEL IS 14XX

x1 & x2 ACTION	STRAIN	x3 & x4 ACTION	STRAIN	x5 & x6 ACTION	STRAIN	x7 & x8 ACTION	STRAIN	x9 & x10 ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
40.20	78.26	39.52	105.66	44.17	55.15	39.52	122.36	40.20	97.73	40.72	97.84
79.81	155.54	79.03	219.12	86.59	185.98	79.03	243.76	79.81	193.65	80.86	199.61
120.01	233.83	118.55	325.74	119.13	270.15	118.55	363.17	120.01	295.40	119.25	297.66
160.21	309.20	158.65	427.48	158.65	369.01	157.49	474.74	160.21	394.22	159.04	394.93
199.82	388.47	197.59	524.32	197.59	466.89	197.01	588.27	199.82	492.08	198.37	492.01
240.02	468.73	237.10	628.66	237.63	569.57	236.52	693.94	240.02	589.74	238.27	589.69
199.82	387.49	196.43	527.24	197.59	468.97	197.01	594.15	199.82	497.74	198.13	495.14
160.21	307.23	157.49	432.34	157.49	367.08	157.49	488.47	160.21	403.02	158.58	399.63
120.01	226.98	118.55	338.42	118.55	267.25	118.55	383.74	120.01	312.[illegible]	119.14	305.68
79.81	143.79	79.03	236.66	78.45	166.43	79.03	274.13	79.81	214.15	79.23	207.03
40.20	65.51	40.10	133.24	39.36	74.41	39.52	156.66	40.20	111.43	39.67	108.39
81.56	148.70	79.03	230.81	91.94	175.23	79.03	262.36	79.81	206.34	80.28	204.69
122.34	230.91	118.55	330.60	119.71	267.25	118.55	373.33	120.01	303.21	119.83	301.18
160.21	308.24	157.49	428.44	157.49	364.16	157.47	433.55	160.21	399.13	158.58	396.70
199.82	388.50	197.59	527.25	200.49	475.74	197.01	593.17	199.82	494.[illegible]	198.95	495.74
240.02	471.70	237.10	624.11	235.52	570.69	236.52	679.85	240.02	591.94	238.04	591.66

LABEL IS 15XX

x1 & x2 ACTION	STRAIN	x3 & x4 ACTION	STRAIN	x5 & x6 ACTION	STRAIN	x7 & x8 ACTION	STRAIN	x9 & x10 ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
39.98	24.42	39.31	109.66	39.31	144.79	39.31	86.11	40.56	43.06	39.69	81.61
79.96	51.77	78.61	251.64	78.61	282.77	78.61	173.19	80.94	[illegible]	79.27	173.21
119.95	87.92	118.49	400.45	119.05	421.74	118.49	267.13	119.75	[illegible]	119.31	271.46
159.93	129.94	159.53	553.17	157.80	546.07	157.80	366.93	160.51	261.53	159.11	371.48
199.91	186.65	197.11	686.31	197.68	679.11	197.11	468.70	200.49	345.91	198.46	473.25
239.89	254.14	236.41	815.52	236.41	800.45	236.41	566.53	239.[illegible]	429.63	237.80	573.66
199.91	185.67	197.11	703.95	196.53	687.92	197.11	472.62	199.41	342.[illegible]	198.11	478.55
159.93	119.18	156.64	576.72	157.22	564.62	157.80	374.75	159.43	257.43	158.31	378.54
119.95	65.43	118.49	447.51	118.49	437.40	118.49	274.93	119.75	178.14	119.08	280.68
79.96	30.24	78.61	303.60	78.61	300.37	78.61	177.97	79.75	105.70	79.15	183.40
39.98	7.76	39.31	146.90	38.73	151.61	39.31	80.21	39.98	43.[illegible]	39.46	85.90
79.96	43.94	79.19	281.[illegible]	82.08	297.43	78.61	177.03	81.12	112.74	80.19	182.60
119.95	81.09	119.[illegible]	470.03	119.49	41[illegible].73	119.47	275.94	119.[illegible]	194.[illegible]	119.19	275.97
159.93	128.00	157.60	554.13	157.80	546.01	157.80	373.80	159.43	264.25	158.65	373.24
199.91	187.65	197.11	688.25	197.68	673.24	197.11	474.62	201.07	346.47	198.58	474.04
239.89	256.12	236.41	818.44	236.41	794.59	236.41	573.45	239.57	429.67	237.80	574.45

LABEL IS 16XX

x1 & x2 ACTION	STRAIN	x3 & x4 ACTION	STRAIN	x5 & x6 ACTION	STRAIN	x7 & x8 ACTION	STRAIN	x9 & x10 ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
39.96	63.49	39.86	85.0[illegible]	38.70	63.58	39.96	48.99	41.11	78.22	39.90	68.05
79.91	131.93	79.14	195.88	81.45	151.61	79.14	96.81	79.41	162.47	79.91	146.13
119.87	206.25	119.00	283.70	119.57	232.94	119.42	167.34	119.67	254.47	119.34	228.92
159.83	294.30	157.70	379.59	158.28	314.10	157.70	247.54	159.43	354.54	158.66	317.98
199.78	378.43	196.98	474.50	198.13	401.23	196.98	334.69	199.79	457.44	198.33	408.22
239.74	462.56	236.83	571.39	236.83	487.41	236.83	422.78	239.74	552.[illegible]	238.00	499.44
199.78	381.36	196.98	479.40	196.98	393.45	196.98	337.64	199.75	457.[illegible]	198.10	410.78
159.83	295.27	157.70	384.49	157.12	299.50	157.70	250.54	159.[illegible]	369.[illegible]	158.43	319.58
119.87	205.27	118.42	287.62	115.11	289.42	118.42	170.28	119.57	273.15	118.54	245.15
76.44	114.29	79.14	190.75	77.98	204.26	79.14	91.00	79.71	192.[illegible]	78.52	156.48
39.96	47.80	39.29	92.90	39.28	123.03	39.96	35.41	39.96	56.12	39.67	75.05
79.91	124.10	79.14	183.90	79.14	209.16	79.14	92.9[illegible]	80.49	179.16	79.56	157.84
119.87	203.33	118.42	278.83	121.15	302.15	119.57	173.2[illegible]	119.47	[illegible]	119.58	244.75
160.40	284.54	157.70	375.70	157.70	390.25	157.70	257.37	159.63	364.[illegible]	158.66	334.40
199.78	365.73	195.98	470.62	196.40	479.35	196.98	343.50	199.79	460.[illegible]	197.98	423.86
239.74	452.80	236.83	567.51	237.41	577.26	236.83	431.59	239.74	552.12	238.11	516.25

TABLE C2 CONTINUED

ACTION T_1 (lb/in) AND MEAN STRAIN ε_x (microstrain) VALUES AT EACH GAUGE POSITION (see fig.6.4) ON MODEL ELEMENTS

LABEL IS 17XX

x1 & x2		x3 & x4		x5 & x6		x7 & x8		x9 & x10		AVERAGED ACTIONS & STRAINS	
ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN		
40.25	75.36	40.15	102.71	38.98	69.46	39.56	60.65	40.83	99.32	39.95	81.60
79.91	145.83	79.13	206.42	82.04	155.58	79.13	140.89	79.91	184.26	80.02	166.73
120.15	219.22	119.27	311.09	118.11	231.91	118.11	222.11	120.15	268.14	119.16	250.50
159.82	291.63	157.68	412.85	158.84	315.11	157.66	304.32	159.82	350.34	158.76	334.85
200.06	365.99	197.24	511.64	197.24	409.25	197.24	397.28	200.64	438.41	198.48	422.72
239.72	442.31	236.80	607.52	236.80	484.42	236.80	495.34	239.72	521.60	237.97	508.24
200.06	368.92	196.66	517.51	196.66	399.28	197.24	406.09	200.06	439.41	198.14	426.24
159.82	292.61	157.68	426.53	157.09	312.18	157.68	316.07	159.82	354.28	158.41	340.33
120.15	220.20	116.95	329.66	116.37	224.09	118.11	232.89	120.15	269.16	118.35	255.20
78.74	142.90	79.13	235.74	77.96	143.84	79.13	149.72	79.32	184.01	78.86	171.24
40.25	72.43	39.56	124.21	35.98	62.60	39.56	66.54	39.50	96.90	39.37	84.54
79.91	140.94	79.13	225.96	79.13	145.79	79.13	147.76	79.91	183.01	79.44	168.69
120.15	214.33	118.11	322.81	118.69	228.09	118.11	229.95	120.15	266.19	119.04	252.26
159.82	288.70	157.68	418.71	159.42	310.22	157.68	314.10	161.57	354.26	159.23	337.20
200.06	364.04	197.24	517.92	197.24	395.36	197.24	401.19	200.06	439.40	198.37	423.50
239.72	440.36	236.80	613.39	236.80	480.51	236.80	488.27	239.72	525.52	237.97	509.61

LABEL IS 18XX

x1 & x2		x3 & x4		x5 & x6		x7 & x8		x9 & x10		AVERAGED ACTIONS & STRAINS	
ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN		
39.76	83.17	39.66	60.63	39.65	74.33	39.66	79.29	39.76	56.79	39.70	70.84
80.68	174.16	78.73	132.04	81.07	158.49	78.73	159.53	80.10	111.59	79.86	147.16
119.85	262.23	118.39	196.63	118.39	234.84	118.39	239.77	121.02	173.21	119.21	221.34
160.20	353.23	158.63	279.78	157.47	314.14	157.47	322.95	160.20	241.70	158.79	302.36
200.54	442.29	199.46	362.95	199.46	400.29	199.46	412.02	200.54	318.02	199.89	387.11
239.71	527.44	239.12	446.12	239.70	492.34	239.12	496.19	239.71	392.40	239.47	470.90
199.95	449.15	198.87	361.96	200.04	407.17	199.46	415.94	199.95	313.15	199.66	389.47
160.20	367.93	157.47	276.84	157.47	317.09	157.47	329.81	158.44	231.34	158.21	304.72
119.85	277.90	117.81	195.63	117.23	233.86	118.39	249.56	119.65	160.51	118.63	223.49
80.10	190.80	78.73	119.30	76.99	151.61	78.75	169.29	78.93	93.00	78.70	144.80
39.76	94.90	39.66	49.92	39.07	79.17	39.66	88.06	39.76	37.22	39.53	69.06
80.10	181.01	79.90	122.24	80.48	162.41	78.73	165.37	80.10	107.57	79.86	147.74
119.85	265.18	118.39	197.58	118.39	233.79	118.39	241.72	119.65	175.13	118.99	223.69
160.20	354.24	157.47	274.88	159.63	321.03	157.47	322.95	160.20	257.53	158.79	304.72
199.95	442.32	199.46	360.98	199.46	409.17	199.46	411.04	199.95	321.77	199.66	388.89
239.71	528.45	239.12	445.13	239.70	495.33	239.12	494.23	239.71	398.30	239.47	472.29

LABEL IS 19XX

x1 & x2		x3 & x4		x5 & x6		x7 & x8		x9 & x10		AVERAGED ACTIONS & STRAINS	
ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN		
39.88	93.01	38.26	67.52	39.21	45.05	40.26	49.36	39.88	87.37	39.48	68.69
80.92	179.20	79.42	139.93	77.84	106.73	80.15	116.41	79.77	[illegible]	79.42	142.67
120.23	259.49	118.20	216.24	117.62	169.39	118.23	191.75	120.23	249.34	118.90	217.04
160.11	338.79	157.99	290.61	155.68	235.97	159.14	270.83	160.11	324.66	158.61	292.91
199.99	419.05	197.19	370.83	197.19	312.33	197.19	347.32	199.99	401.24	198.31	370.10
239.88	498.33	236.40	451.79	236.40	382.81	236.40	420.52	[illegible]	477.45	237.79	446.63
199.99	423.95	197.19	372.76	196.24	302.56	197.19	354.15	199.99	[illegible]	198.08	371.47
160.11	349.57	157.99	291.57	155.68	225.24	157.94	273.92	160.11	[illegible]	158.26	294.17
120.23	270.26	118.20	214.25	117.62	154.76	118.23	200.52	120.23	259.10	118.90	219.79
79.77	191.97	78.99	134.03	77.84	87.21	78.39	124.20	79.77	[illegible]	79.07	143.06
39.88	106.77	38.63	51.85	39.21	33.34	39.21	50.64	38.15	92.68	39.07	66.72
79.77	184.02	78.99	130.13	77.39	93.06	79.39	118.34	79.77	[illegible]	79.30	140.31
120.81	267.32	118.20	209.35	117.25	163.54	118.20	193.62	121.73	[illegible]	119.36	216.46
160.11	344.66	157.99	288.64	157.44	232.07	157.44	269.02	160.11	423.71	158.84	291.62
199.99	420.03	197.19	368.97	197.19	308.42	197.17	349.25	199.99	[illegible]	198.31	369.13
239.30	501.27	236.40	449.10	236.40	384.77	236.40	429.43	[illegible]	472.48	237.68	447.42

LABEL IS 20XX

x1 & x2		x3 & x4		x5 & x6		x7 & x8		x9 & x10		AVERAGED ACTIONS & STRAINS	
ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN		
40.57	51.97	39.16	52.76	39.32	72.42	39.32	116.42	41.15	67.43	39.70	72.21
79.99	108.93	78.63	125.16	78.53	133.96	78.53	226.92	79.39	144.59	79.17	149.51
119.98	166.59	118.53	200.44	115.53	222.16	119.53	331.64	[illegible]	[illegible]	119.11	229.15
159.97	229.26	157.84	276.74	157.84	301.44	157.84	432.39	159.47	[illegible]	158.69	309.58
199.96	291.91	197.16	358.00	197.16	387.57	197.16	520.44	[illegible]	[illegible]	198.28	388.45
239.96	357.50	236.47	438.23	236.47	471.73	238.21	615.34	[illegible]	461.90	238.21	468.88
199.96	291.93	197.16	361.92	197.16	399.56	197.16	531.27	[illegible]	[illegible]	199.28	392.56
159.97	227.34	157.25	285.61	157.25	303.44	157.84	445.11	[illegible]	[illegible]	158.46	315.07
119.98	162.74	118.53	212.24	117.95	224.15	119.53	357.03	[illegible]	[illegible]	118.99	233.36
78.25	100.07	78.63	132.93	78.53	141.39	78.63	251.17	[illegible]	156.29	78.83	158.33
39.99	48.14	39.32	57.70	37.58	60.74	39.32	152.50	[illegible]	71.41	39.24	78.09
79.99	105.90	78.63	130.49	80.37	142.94	78.63	248.46	[illegible]	[illegible]	79.52	155.58
119.98	166.61	119.53	207.35	119.53	222.27	119.53	343.35	[illegible]	[illegible]	119.11	233.66
159.97	228.29	157.84	281.71	157.84	309.30	157.84	433.36	161.13	[illegible]	158.93	312.72
199.96	291.93	197.16	359.97	197.74	394.43	197.16	524.34	[illegible]	[illegible]	198.51	391.78
240.54	353.61	236.47	439.22	235.90	475.66	236.47	611.42	[illegible]	[illegible]	237.87	468.89

TABLE C2 CONTINUED

ACTION T_i (lb/in) AND MEAN STRAIN ε_x (microstrain) VALUES AT EACH GAUGE POSITION (see fig.6.4) ON MODEL ELEMENTS

LABEL IS 21XX

x1 & x2 ACTION	STRAIN	x3 & x4 ACTION	STRAIN	x5 & x6 ACTION	STRAIN	x7 & x8 ACTION	STRAIN	x9 & x10 ACTION	STRAIN	AVERAGED ACTIONS &	STRAINS
39.90	46.00	39.22	85.15	40.95	97.90	39.22	51.68	39.90	44.03	39.88	64.99
79.80	95.91	78.45	170.30	77.37	189.88	78.45	121.36	79.80	94.93	79.65	135.47
120.28	155.61	118.25	248.58	115.92	279.91	118.25	192.80	120.28	155.61	118.95	207.31
160.17	219.24	157.47	326.86	157.47	365.04	157.47	267.18	160.17	218.25	158.60	280.34
200.07	283.83	197.27	402.20	198.43	450.17	197.27	343.50	200.07	281.86	198.25	354.34
239.97	252.24	236.49	478.52	236.49	526.50	236.49	419.83	239.97	350.37	238.13	428.35
200.07	287.75	197.27	407.10	196.69	448.22	197.27	347.42	200.07	280.49	198.14	357.87
160.17	223.16	157.47	332.74	157.47	368.96	157.47	273.05	160.17	216.30	158.37	284.86
120.28	161.50	118.25	255.44	117.09	284.80	118.25	203.56	120.28	153.06	118.95	213.60
78.64	97.88	78.45	177.15	78.45	203.57	77.29	129.13	79.80	92.00	79.07	140.96
38.74	46.98	39.22	91.97	38.65	106.68	39.22	58.71	39.90	36.20	38.84	66.95
79.80	95.92	78.45	174.18	78.45	197.70	79.02	129.19	79.80	90.73	79.42	138.80
119.70	155.63	119.25	249.53	118.25	280.88	118.25	199.64	120.28	151.70	119.07	210.26
160.17	220.23	157.47	326.83	157.47	362.10	157.47	272.06	160.17	214.35	158.60	282.11
200.07	285.81	197.27	406.09	197.27	445.28	197.27	348.39	200.07	275.72	198.48	356.50
239.97	353.34	236.49	479.48	236.49	525.53	236.49	421.77	239.97	344.92	238.13	429.34

LABEL IS 22XX

x1 & x2 ACTION	STRAIN	x3 & x4 ACTION	STRAIN	x5 & x6 ACTION	STRAIN	x7 & x8 ACTION	STRAIN	x9 & x10 ACTION	STRAIN	AVERAGED ACTIONS &	STRAINS
39.94	54.84	39.94	50.74	40.42	68.50	39.26	96.97	39.94	47.39	39.84	64.99
79.88	110.65	80.26	134.06	79.11	141.90	79.11	193.76	79.88	96.36	78.87	134.48
119.82	176.25	118.37	210.39	118.37	214.30	118.37	286.75	119.82	149.97	119.17	206.50
159.76	244.79	157.64	287.72	158.21	286.71	157.64	374.85	159.76	207.53	158.55	279.31
200.28	314.31	196.90	366.01	196.70	361.08	196.90	460.02	200.28	270.29	198.62	352.31
240.22	384.81	236.74	444.31	235.74	435.49	236.74	545.19	240.22	331.17	237.89	405.49
200.28	321.17	196.90	373.94	195.32	357.17	196.90	470.80	200.28	266.49	198.28	354.27
159.76	251.66	157.64	297.50	157.64	283.79	157.64	389.55	159.76	201.78	158.55	282.84
119.82	183.13	118.37	224.09	118.37	209.41	118.37	310.25	119.82	141.08	118.83	211.79
79.88	113.62	79.11	148.73	78.53	139.04	77.95	221.13	79.94	96.24	78.53	139.96
38.78	50.93	39.26	71.41	39.95	56.75	39.26	120.36	39.94	[illegible]	39.15	68.11
79.88	112.62	79.11	146.74	79.11	135.01	79.11	208.45	79.88	[illegible]	79.10	137.40
119.82	176.26	118.37	220.19	118.95	211.36	118.37	295.57	119.82	147.97	118.94	207.48
159.76	245.78	157.64	294.58	158.21	283.79	157.64	378.75	159.76	207.24	158.55	278.92
200.28	313.34	198.05	372.87	196.90	358.16	196.90	463.94	200.28	274.21	198.39	352.12
240.22	382.87	236.74	449.22	236.74	432.53	236.74	546.17	240.22	339.39	237.89	424.93

LABEL IS 23XX

x1 & x2 ACTION	STRAIN	x3 & x4 ACTION	STRAIN	x5 & x6 ACTION	STRAIN	x7 & x8 ACTION	STRAIN	x9 & x10 ACTION	STRAIN	AVERAGED ACTIONS &	STRAINS
39.91	56.75	39.23	66.51	40.36	41.11	39.23	53.93	39.91	61.77	39.85	55.98
79.82	130.12	79.04	139.57	79.04	101.55	79.04	105.73	79.82	142.14	79.35	123.91
119.73	202.55	118.28	217.15	118.28	171.40	120.01	174.23	119.73	221.36	119.20	197.34
160.22	275.99	157.51	290.53	159.24	242.89	157.51	245.71	160.22	297.74	158.94	270.57
200.13	348.44	197.32	366.97	197.32	309.51	197.32	322.10	200.13	367.22	198.44	343.03
240.03	417.00	236.56	439.30	236.56	378.06	236.56	408.25	240.03	447.71	237.95	416.67
200.13	352.39	197.32	370.96	197.32	311.49	196.75	331.92	200.13	374.12	198.33	349.15
160.22	284.94	157.51	299.37	158.36	241.97	157.51	266.32	160.22	[illegible]	158.36	279.62
119.73	214.33	118.29	226.97	118.55	175.39	118.29	198.76	119.73	232.19	118.51	209.53
78.66	134.06	78.47	153.58	79.62	111.74	79.04	126.27	79.82	153.45	79.12	135.90
39.33	49.87	39.23	73.36	39.81	52.93	39.23	59.72	39.91	72.86	39.50	61.69
79.82	130.15	79.04	149.59	79.04	108.75	79.04	120.41	79.82	144.97	79.35	131.38
119.73	202.59	118.29	221.39	117.70	171.44	118.29	167.96	119.73	223.24	118.74	201.28
160.22	275.04	157.51	292.52	157.51	234.00	157.51	253.45	160.22	296.76	158.59	272.56
200.13	345.54	197.32	364.93	197.32	309.50	197.32	332.89	200.13	369.24	198.44	344.42
240.03	415.36	236.56	436.37	236.56	378.05	236.55	405.36	240.03	439.74	237.95	414.92

LABEL IS 24XX

x1 & x2 ACTION	STRAIN	x3 & x4 ACTION	STRAIN	x5 & x6 ACTION	STRAIN	x7 & x8 ACTION	STRAIN	x9 & x10 ACTION	STRAIN	AVERAGED ACTIONS &	STRAINS
39.80	43.09	39.70	63.52	41.43	42.35	39.70	38.17	[illegible]	73.37	40.09	52.04
80.15	104.75	78.83	136.87	79.83	88.04	78.83	95.84	80.18	162.19	79.37	117.78
119.98	166.42	118.53	210.25	121.41	136.94	118.53	173.31	119.98	241.50	119.68	185.11
159.78	229.08	157.66	279.73	155.61	184.92	157.66	239.80	159.78	319.48	158.74	250.50
200.16	292.73	197.36	346.28	197.35	242.70	197.36	314.20	200.15	399.58	198.48	318.25
239.96	354.42	237.06	413.84	236.49	304.42	236.49	387.63	239.96	470.71	237.99	386.20
200.16	295.71	197.36	350.23	197.36	240.87	197.36	321.08	200.16	406.17	198.48	322.40
159.75	234.04	157.66	283.63	155.35	174.14	156.51	246.70	159.78	331.76	157.81	254.87
119.98	174.33	118.53	215.19	118.53	127.24	118.53	180.13	119.98	255.41	118.99	190.66
80.18	108.75	78.83	145.71	79.65	71.44	78.83	109.85	80.18	159.95	78.33	124.30
39.60	41.19	39.70	71.35	39.70	34.25	39.70	40.14	39.60	98.46	39.74	57.15
80.18	105.79	78.83	139.82	79.83	81.23	78.83	105.71	80.18	175.14	79.37	121.54
119.98	167.44	119.11	208.31	118.53	130.05	118.53	177.15	119.98	244.20	119.22	186.91
159.75	255.46	157.66	276.81	157.66	[illegible]	157.66	249.65	159.78	[illegible]	158.51	258.15
200.18	317.13	197.36	343.36	197.36	246.66	197.36	320.07	200.15	397.02	198.48	324.91
239.96	378.82	236.49	408.94	236.49	310.31	237.64	392.51	239.96	464.78	236.10	391.87

TABLE C2 CONTINUED

ACTION T_1 (lb/in) AND MEAN STRAIN ϵ_y (micrstrain) VALUES AT EACH GAUGE POSITION (see fig.6.4.)

LABEL IS 1YY

y1&y2 ACTION	y1&y2 STRAIN	y3&y4 ACTION	y3&y4 STRAIN	y5&y6 ACTION	y5&y6 STRAIN	y7 & y8 ACTION	y7 & y8 STRAIN	y9&y10 ACTION	y9&y10 STRAIN	AVERAGED ACTIONS & STRAINS	
19.99	135.04	19.99	157.50	19.99	192.77	20.58	177.10	19.99	134.05	20.10	159.29
39.97	273.96	39.97	356.11	40.56	425.66	39.97	356.18	39.97	249.52	40.09	332.29
59.96	406.99	59.96	553.71	59.96	625.28	59.96	542.10	59.96	376.71	59.96	500.96
79.95	548.83	79.95	737.58	81.12	844.45	79.95	726.04	79.95	513.71	80.18	674.12
99.94	698.44	99.94	922.42	99.94	1024.48	99.94	915.87	99.94	658.52	99.94	843.94
119.92	853.90	119.92	1101.37	119.92	1218.19	119.92	1094.89	119.92	806.27	119.92	1014.92
99.94	708.17	99.94	938.02	99.35	1040.15	99.94	927.59	99.94	662.45	99.82	855.27
79.95	559.48	79.95	761.94	77.60	844.46	79.95	755.37	79.95	519.60	79.48	688.17
59.96	418.62	59.96	580.95	59.96	669.33	59.96	577.29	59.96	389.43	59.96	527.12
42.33	297.32	39.97	394.11	39.97	467.75	39.97	396.25	39.97	258.30	40.44	362.75
18.22	144.77	19.99	206.29	19.99	242.66	19.99	209.34	19.99	138.99	19.63	188.39
41.15	288.53	39.97	381.38	39.97	454.00	39.97	383.52	39.97	256.32	40.21	352.75
59.96	420.54	59.96	555.47	60.55	659.47	59.96	568.44	59.96	388.42	60.08	518.47
79.95	565.25	79.95	750.08	79.95	857.10	79.95	753.36	79.95	524.63	79.95	690.04
99.94	706.04	99.94	925.11	99.94	1048.86	99.94	930.43	99.94	669.24	99.94	855.93
119.92	859.50	119.92	1114.79	119.92	1246.50	120.51	1117.28	119.92	818.95	120.04	1031.40

LABEL IS 2YY

ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
19.81	169.31	20.97	176.18	19.81	128.19	19.81	143.83	19.22	168.34	19.92	157.17
39.61	362.08	41.36	367.98	39.61	269.07	39.61	290.63	39.61	345.48	39.96	327.05
60.00	554.79	60.00	540.19	60.00	475.43	60.00	437.39	60.00	526.51	60.00	506.86
79.80	741.59	79.80	737.82	79.80	593.76	79.80	584.15	79.80	693.81	79.80	670.23
99.61	923.42	99.61	924.68	99.61	754.15	99.61	732.83	99.61	847.41	99.61	836.50
119.42	1102.27	119.42	1117.39	119.42	928.19	119.42	884.47	119.42	1[illegible]15.68	119.42	1009.60
99.61	945.70	99.61	953.01	99.61	773.60	99.61	737.71	99.61	863.[illegible]	99.61	854.62
79.80	790.16	79.80	778.85	79.80	612.19	79.80	569.99	79.80	714.34	79.80	697.11
60.00	620.90	60.00	597.85	59.42	446.86	60.00	447.13	60.00	559.75	59.88	534.50
39.61	442.87	39.61	412.93	39.61	299.16	39.61	296.48	39.61	389.51	39.61	368.19
19.81	244.33	18.64	204.53	19.81	158.34	19.81	155.58	19.81	217.24	19.57	196.01
39.61	414.54	40.19	385.55	40.78	305.05	39.61	299.41	39.61	376.78	39.96	356.26
60.00	590.57	60.00	576.35	60.00	447.83	60.00	443.25	60.00	549.[illegible]1	60.00	521.40
79.80	762.65	79.80	765.17	79.80	613.08	79.80	593.9[illegible]	79.80	7[illegible]8.51	79.80	688.66
99.61	936.60	99.61	951.04	99.61	775.38	99.61	736.75	99.61	[illegible]64.[illegible]	99.61	852.77
119.42	1114.36	119.42	1132.01	119.42	943.51	119.42	890.34	119.42	1[illegible]23.57	119.42	1020.76

LABEL IS 3YY

ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
19.75	135.04	19.75	121.26	20.33	120.36	19.75	169.26	19.75	154.54	19.86	140.09
40.08	291.58	41.24	261.14	40.08	250.50	40.08	339.5[illegible]	40.08	323.73	40.31	293.29
61.57	462.73	60.41	404.88	60.41	390.39	59.83	510.65	59.83	489.[illegible]	60.41	451.53
80.16	610.37	80.16	557.39	80.16	542.02	80.16	678.86	80.16	661.12	80.16	609.95
101.07	770.71	100.48	708.90	97.90	685.81	99.90	831.42	99.90	817.71	100.25	761.91
119.65	921.23	121.39	868.19	120.23	841.34	119.65	988.85	119.65	967.29	120.12	917.38
99.90	785.35	99.90	733.26	99.90	709.32	99.90	853.91	99.90	836.29	99.90	783.62
80.16	655.33	79.57	600.31	80.16	578.29	80.16	719.97	80.16	697.45	80.04	650.27
58.66	508.71	59.83	467.37	59.83	441.40	59.25	563.54	59.83	542.36	59.48	504.80
38.92	370.88	40.08	335.43	40.08	311.35	40.08	411.01	40.08	381.60	39.85	362.05
19.75	222.24	19.75	198.56	18.59	177.33	19.75	227.15	19.75	228.48	19.52	206.75
41.24	363.14	40.08	319.84	40.08	297.69	40.08	372.97	40.08	358.16	40.31	342.36
59.83	495.21	59.83	453.82	59.25	419.03	59.83	533.43	59.83	521.55	59.71	484.61
80.16	642.94	80.16	600.52	80.16	561.92	80.16	695.85	80.16	681.39	80.16	636.64
99.90	784.78	99.90	741.32	99.90	696.97	101.07	854.37	99.90	832.66	100.14	782.02
120.81	925.66	119.65	885.05	119.65	839.88	119.65	993.31	119.65	983.40	119.88	925.46

LABEL IS 4YY

ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
19.64	152.71	20.22	187.30	21.38	188.93	20.22	181.15	20.22	181.15	20.34	178.19
40.44	299.51	41.02	362.17	41.02	354.25	39.86	330.88	39.86	330.88	40.44	335.54
60.08	444.38	58.93	502.11	60.08	510.71	60.08	469.77	60.08	469.77	59.85	479.35
79.73	593.15	78.57	662.55	79.73	671.03	80.30	606.71	80.30	606.71	79.73	628.03
99.95	740.98	98.21	808.31	99.95	820.52	99.95	741.63	99.95	741.63	99.60	770.61
120.74	901.54	119.59	973.59	118.43	969.80	119.59	875.55	119.59	875.55	119.59	919.21
99.95	785.05	99.95	853.21	98.79	845.49	99.95	753.25	99.95	753.25	99.71	798.05
79.73	667.57	79.73	725.97	79.73	732.04	79.15	637.79	79.15	637.79	79.49	680.23
60.08	552.03	60.08	591.87	59.35	583.40	60.08	522.33	60.08	522.33	59.74	554.39
39.86	426.69	39.86	451.90	39.29	453.35	39.29	392.20	39.29	392.20	39.52	423.27
20.22	296.47	20.22	294.35	19.06	296.99	20.22	259.16	20.22	259.16	19.99	281.22
39.86	398.22	39.86	421.55	39.86	437.77	39.86	387.31	39.86	387.31	39.86	406.43
60.08	511.72	61.82	567.33	60.08	579.60	60.08	516.62	60.08	516.62	60.43	534.38
80.30	640.87	79.73	696.42	79.73	722.36	79.73	638.60	79.73	638.60	79.84	667.37
99.95	761.22	99.95	840.17	99.95	863.15	100.52	770.54	100.52	770.54	100.18	801.12
119.59	898.21	119.59	982.90	119.59	1003.93	119.59	898.54	119.59	898.54	119.59	936.42

TABLE C2 CONTINUED

ACTION T_z (lb/in) AND MEAN STRAIN ε_y (micrstrain) VALUES AT EACH GAUGE POSITION (see fig 6.4.)

LABEL IS 5YY

y1&y2		y3&y4		y5&y6		y7 & y8		y9 & y10		AVERAGED ACTIONS & STRAINS	
ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN		
20.14	87.11	20.14	110.55	20.14	124.26	20.14	127.21	20.14	104.70	20.14	110.77
41.43	185.93	39.70	222.04	40.85	252.43	39.70	245.62	39.70	207.46	40.28	222.70
59.84	275.95	59.84	339.40	59.84	365.91	59.84	369.90	59.84	309.26	59.84	332.09
81.13	384.53	79.98	449.92	79.98	490.16	79.98	496.14	79.98	418.88	80.21	447.93
98.97	473.55	100.12	565.31	99.54	610.48	100.12	616.50	99.54	521.64	99.66	557.50
119.68	578.22	119.68	673.85	119.68	732.78	118.53	738.82	119.69	628.33	119.45	670.40
99.54	483.33	98.97	565.27	98.97	612.47	99.54	620.45	99.54	522.69	99.31	560.84
79.98	395.29	79.98	462.58	79.98	508.78	79.98	508.92	79.98	419.97	79.98	459.11
59.84	299.43	59.84	351.09	59.84	382.60	59.84	383.69	59.84	328.96	59.84	349.15
39.70	202.57	39.70	237.64	39.70	262.28	39.70	264.32	39.70	227.17	39.70	238.80
18.41	97.88	20.14	122.26	20.14	142.92	20.14	141.01	20.14	121.44	19.79	125.10
39.70	194.74	39.70	228.86	42.00	262.29	39.70	259.41	39.70	224.19	40.16	233.90
59.84	289.64	59.84	345.23	60.42	382.61	59.84	379.79	59.84	326.96	59.96	344.85
79.98	387.53	79.98	455.75	79.98	503.93	79.98	505.05	79.98	437.56	79.98	457.96
99.54	483.35	100.12	569.17	99.54	622.32	99.54	620.53	99.54	540.33	99.66	567.14
120.26	587.04	119.68	682.59	119.68	745.59	119.68	746.78	119.68	649.96	119.80	682.39

LABEL IS 6YY

ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
19.26	81.22	19.84	140.84	19.84	177.07	19.84	138.95	19.84	92.04	19.72	126.03
39.68	172.23	39.68	294.39	39.68	351.16	39.68	269.05	39.68	196.74	39.68	256.71
60.69	273.97	59.52	448.89	60.10	523.30	60.10	406.96	60.10	312.20	60.10	393.06
79.94	376.68	79.94	587.74	79.94	682.70	79.94	537.04	79.94	431.98	79.94	523.15
99.78	493.05	99.78	728.51	99.78	831.30	99.78	666.09	99.78	551.93	99.78	654.18
119.62	608.41	119.62	862.41	119.62	981.79	120.20	801.96	119.62	678.17	119.74	786.55
100.95	511.56	99.78	744.04	99.78	848.74	99.78	677.69	99.78	561.72	100.01	668.75
79.94	403.96	79.94	621.79	79.94	722.56	79.94	555.43	79.94	446.26	79.94	550.00
58.35	295.38	59.52	483.89	59.52	569.98	58.35	422.41	60.10	334.70	59.17	421.27
39.68	205.39	39.10	346.00	39.68	421.34	39.68	295.27	39.68	217.26	39.56	297.05
19.84	107.60	19.84	201.32	19.84	245.38	19.84	160.36	19.84	101.80	19.84	163.29
39.68	202.47	39.68	337.25	39.68	397.94	40.26	290.45	39.68	208.45	39.80	287.31
61.27	306.15	60.10	476.10	60.10	556.36	60.69	417.60	60.10	320.98	60.45	415.44
79.94	402.98	79.94	621.80	79.94	708.90	79.94	543.76	79.94	440.38	79.94	543.56
99.78	509.59	99.78	758.65	99.78	857.52	99.78	668.93	99.78	555.85	99.78	670.11
119.62	620.08	119.62	892.51	119.62	1000.22	119.62	800.91	119.62	679.15	119.62	798.57

LABEL IS 7YY

ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
20.16	74.36	20.16	124.33	20.16	193.82	20.16	146.89	20.16	83.21	20.16	124.52
39.74	160.45	41.47	257.42	39.74	378.73	39.74	293.72	39.74	178.11	40.08	253.69
61.62	267.11	59.90	378.77	59.90	549.94	59.32	443.49	59.90	273.74	60.13	382.47
80.05	361.00	80.05	499.14	80.05	696.67	78.90	582.57	79.48	378.74	79.71	503.61
99.63	462.72	99.63	617.55	99.63	817.95	99.63	727.37	99.63	469.34	99.63	622.99
120.94	584.95	119.79	738.91	119.79	951.95	119.79	862.47	119.79	604.84	120.02	748.62
99.06	477.37	99.66	630.32	99.63	836.53	99.63	744.07	99.63	499.16	99.40	637.49
79.48	387.39	80.05	523.68	80.05	724.99	80.05	623.71	80.05	397.39	79.94	531.43
59.32	288.59	59.32	409.20	59.32	588.63	59.32	492.54	59.90	290.71	59.43	413.81
39.74	200.56	39.74	294.69	39.74	446.15	39.74	360.38	39.74	193.79	39.74	299.11
20.16	114.48	20.16	162.56	19.01	266.15	20.16	214.47	20.16	89.5	19.93	169.34
40.89	200.51	40.31	281.93	39.74	421.68	39.74	340.77	39.74	184.96	40.08	285.97
59.90	285.58	59.90	399.36	59.90	569.40	60.47	479.79	59.90	279.91	60.01	402.81
80.63	384.31	80.05	513.85	80.05	709.27	80.05	607.07	80.05	384.64	80.17	519.83
99.63	476.20	99.63	628.36	99.63	836.42	99.63	740.21	99.63	493.28	99.63	634.89
119.79	582.74	120.37	749.72	119.79	967.45	119.79	870.41	119.79	607.32	119.91	755.63

LABEL IS 8YY

ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
20.23	134.09	20.23	157.57	20.23	170.26	20.23	197.68	20.23	165.35	20.23	164.99
40.47	299.47	35.54	316.14	40.47	354.20	39.89	394.33	39.89	344.36	39.31	341.70
60.12	466.81	60.12	520.67	61.28	525.44	60.12	579.27	60.12	515.54	60.35	521.55
79.78	629.28	79.78	682.19	79.78	668.32	79.78	739.75	79.78	679.46	79.78	679.88
100.01	782.96	100.01	841.77	100.01	818.07	100.01	890.46	100.01	832.43	100.01	833.14
119.67	930.78	120.24	1003.40	119.67	965.87	119.67	1037.23	119.67	983.99	119.78	984.25
100.01	818.31	100.01	879.19	98.28	835.76	100.01	919.84	100.01	864.67	99.66	863.55
79.78	700.93	79.78	754.90	79.78	724.24	79.78	744.63	79.78	742.41	79.78	743.42
60.12	569.84	58.39	611.04	60.12	593.15	60.12	663.54	60.12	613.31	59.78	610.18
39.89	424.98	39.89	480.92	39.89	450.30	39.89	517.76	39.89	467.59	39.89	468.29
19.08	276.21	19.08	301.52	20.23	295.64	20.23	344.54	20.23	300.54	19.77	303.65
39.89	403.39	39.89	432.71	40.47	427.75	39.89	484.47	39.89	432.41	40.00	436.15
60.12	541.40	60.12	576.64	60.12	567.72	60.12	629.31	60.12	573.27	60.12	577.67
79.78	671.60	80.36	719.62	79.78	699.86	79.78	769.25	79.78	714.12	79.89	714.89
100.01	800.83	100.01	863.61	100.01	836.91	100.01	909.2	100.01	853. 2	100.01	852.71
119.67	937.91	119.67	1012.66	119.67	977.91	120.24	1048.17	119.67	998.73	119.78	995.08

TABLE C2 CONTINUED

ACTION T_1 (lb/in) AND MEAN STRAIN ε_y (micrstrain) VALUES AT EACH GAUGE POSITION (see fig.6.4.)

LABEL IS 9YY

y1&y2 ACTION	y1&y2 STRAIN	y3&y4 ACTION	y3&y4 STRAIN	y5&y6 ACTION	y5&y6 STRAIN	y7&y8 ACTION	y7&y8 STRAIN	y9&y10 ACTION	y9&y10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
20.22	134.09	20.22	157.57	20.22	170.26	20.22	109.60	20.22	105.68	20.22	135.44
39.87	299.47	35.82	316.14	40.45	354.20	39.87	220.20	39.87	203.55	39.17	278.71
60.09	466.81	60.09	520.67	61.25	525.44	60.67	330.79	60.09	299.46	60.44	428.64
79.74	629.28	79.74	682.19	79.74	668.32	79.74	436.50	79.74	397.33	79.74	562.73
99.96	782.96	99.96	841.77	99.96	818.07	99.96	541.24	99.96	496.19	99.96	696.05
119.60	930.78	120.18	1003.40	119.60	965.87	119.60	649.89	119.60	592.13	119.72	828.41
99.96	818.31	99.96	879.19	98.23	835.76	99.96	545.19	99.96	499.18	99.61	715.53
79.74	700.93	79.74	754.90	79.74	724.24	79.74	443.43	79.74	403.31	79.74	605.36
60.09	569.84	58.36	618.89	60.09	593.15	60.09	337.76	60.09	316.22	59.74	487.17
39.87	424.98	39.87	480.82	39.87	450.30	39.87	235.00	39.87	217.38	39.87	361.70
19.07	276.21	19.07	301.52	20.22	295.64	20.22	124.37	20.22	116.55	19.76	222.86
39.87	403.39	39.87	432.71	40.45	427.75	39.87	229.08	39.87	211.46	39.98	340.88
60.09	541.40	60.09	576.64	60.09	567.72	60.09	330.88	60.09	312.27	60.09	465.78
79.74	671.60	80.31	719.62	79.74	699.86	79.74	441.48	79.74	412.10	79.85	588.93
99.96	800.83	99.96	863.61	99.96	836.91	99.96	548.18	99.96	509.01	99.96	711.71
119.60	937.91	119.60	1012.66	119.60	977.91	119.60	652.91	119.60	606.91	119.60	837.66

LABEL IS 10YY

y1&y2 ACTION	y1&y2 STRAIN	y3&y4 ACTION	y3&y4 STRAIN	y5&y6 ACTION	y5&y6 STRAIN	y7&y8 ACTION	y7&y8 STRAIN	y9&y10 ACTION	y9&y10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
19.60	87.10	20.18	102.74	20.18	117.42	20.18	114.56	20.18	98.85	20.06	104.13
39.77	187.87	41.50	229.92	39.77	241.66	39.77	227.12	39.77	197.66	40.12	216.84
61.10	290.58	59.95	336.52	59.95	364.89	59.95	330.86	59.95	296.41	60.18	323.85
80.70	395.23	80.13	453.86	80.13	485.19	80.13	448.26	80.13	398.09	80.24	436.12
99.72	497.92	99.72	559.46	99.72	599.60	99.72	555.88	99.72	500.72	99.72	542.72
119.90	611.34	119.90	672.87	120.48	719.88	117.59	657.62	119.90	602.35	119.55	652.81
99.72	516.48	99.72	573.12	99.72	611.31	99.72	568.60	99.72	502.59	99.72	554.42
80.13	426.52	80.13	472.39	79.55	506.67	80.13	461.01	80.13	405.77	80.01	454.47
59.95	325.81	59.95	368.74	59.37	396.17	59.95	359.27	59.95	305.04	59.83	351.01
39.77	229.00	39.77	251.40	39.77	276.87	39.77	243.85	39.77	205.31	39.77	241.29
20.18	123.35	18.45	124.23	20.18	156.55	20.18	135.20	20.18	114.37	19.83	130.74
41.50	224.09	39.77	243.57	39.77	265.13	39.77	237.96	39.77	202.40	40.12	234.63
60.53	315.05	59.95	358.98	59.95	386.41	59.95	349.52	59.95	302.14	60.07	342.42
80.13	412.86	80.13	469.50	80.13	503.79	80.13	463.03	80.13	403.81	80.13	450.60
99.72	511.64	99.72	566.33	99.72	614.31	99.72	571.65	99.72	503.51	99.72	553.49
119.90	617.26	119.90	684.63	120.48	731.67	119.90	687.12	119.90	606.12	120.01	665.36

LABEL IS 11YY

y1&y2 ACTION	y1&y2 STRAIN	y3&y4 ACTION	y3&y4 STRAIN	y5&y6 ACTION	y5&y6 STRAIN	y7&y8 ACTION	y7&y8 STRAIN	y9&y10 ACTION	y9&y10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
20.15	113.50	20.15	100.78	20.15	92.98	20.15	91.01	20.15	98.84	20.15	99.42
39.72	227.94	39.72	215.24	39.72	193.76	39.72	192.77	39.72	202.56	39.72	206.45
59.87	349.21	59.87	328.72	59.87	285.74	59.30	295.52	59.87	306.30	59.76	313.10
80.60	476.35	80.02	438.29	80.02	383.57	80.02	389.47	80.02	414.90	80.14	420.52
100.17	588.82	99.59	544.93	99.59	476.53	99.59	490.24	99.59	512.74	99.71	522.65
119.74	701.30	120.32	656.46	119.74	576.35	119.74	592.98	119.74	611.56	119.86	627.73
99.59	613.29	99.59	564.53	99.59	489.29	99.59	504.93	99.59	522.55	99.59	538.92
80.02	520.40	80.02	471.64	80.02	402.25	80.02	416.90	80.02	432.57	80.02	448.75
59.30	417.75	59.87	377.78	59.87	310.37	59.87	317.16	59.87	333.81	59.76	351.38
39.72	316.07	38.57	262.40	39.72	226.24	39.72	221.32	39.72	239.90	39.49	253.19
19.57	202.59	19.57	157.70	20.15	130.34	20.15	116.63	20.15	132.26	19.92	147.90
39.72	299.45	39.72	253.59	39.72	222.32	39.72	208.61	39.72	224.24	39.72	241.64
59.87	402.16	59.87	356.32	60.45	314.32	59.87	305.49	59.87	319.16	59.99	339.49
80.02	504.88	80.02	461.03	80.02	401.42	80.02	406.26	80.02	419.94	80.02	438.70
100.17	605.64	99.59	557.93	99.59	487.55	99.59	501.18	99.59	513.87	99.71	533.24
119.74	704.46	119.74	659.72	119.74	584.47	119.74	599.04	119.74	610.75	119.74	631.69

LABEL IS 12YY

y1&y2 ACTION	y1&y2 STRAIN	y3&y4 ACTION	y3&y4 STRAIN	y5&y6 ACTION	y5&y6 STRAIN	y7&y8 ACTION	y7&y8 STRAIN	y9&y10 ACTION	y9&y10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
20.19	104.70	20.19	110.59	20.19	122.31	20.19	110.62	19.61	90.03	20.07	107.65
39.80	207.41	39.80	218.22	40.38	234.83	39.80	230.99	39.22	202.57	39.80	218.80
59.99	329.68	59.99	318.99	59.99	341.47	59.99	356.25	59.41	317.09	59.87	332.70
79.60	439.26	79.60	420.77	80.75	452.02	79.60	473.70	79.22	439.43	79.72	445.04
101.52	558.63	99.79	518.66	100.37	553.78	99.79	587.24	98.64	557.85	100.02	555.23
119.98	658.45	119.98	623.40	119.98	655.55	120.55	704.70	117.67	671.40	119.63	662.70
99.79	574.33	99.21	529.48	99.79	554.79	99.79	600.99	99.79	581.38	99.67	568.19
79.60	485.31	79.60	444.36	79.60	457.95	79.60	499.25	79.60	476.70	79.60	472.71
59.99	397.29	59.99	352.40	59.41	361.12	59.99	399.44	59.99	369.09	59.87	375.87
39.80	299.48	39.80	255.55	39.80	271.14	39.80	294.74	39.80	275.17	39.80	279.21
20.19	195.75	19.61	152.77	20.19	170.33	20.19	182.16	19.61	156.71	19.96	171.54
39.80	283.83	40.38	252.61	39.80	266.24	39.80	282.02	39.80	259.49	39.92	268.84
59.99	383.67	59.99	343.68	59.99	361.20	59.99	391.65	59.99	376.98	59.99	371.44
79.60	476.68	79.60	437.70	79.60	459.09	79.60	503.27	79.60	493.47	79.60	474.04
99.79	540.25	99.79	532.70	99.79	557.97	100.37	616.85	99.79	609.98	99.90	571.55
119.98	641.11	119.98	630.66	119.98	659.80	119.98	721.65	119.98	727.49	119.98	676.14

TABLE C2 CONTINUED

ACTION T_x (lb/in) AND MEAN STRAIN ε_y (micrstrain) VALUES AT EACH GAUGE POSITION (see fig 6.4.)

y1 & y2 — y3 & y4 — y5 & y6 — y7 & y8 — y9 & y10

LABEL IS 13YY

ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	AVERAGED ACTIONS &	STRAINS
19.61	74.35	20.19	87.10	20.19	88.10	20.19	84.16	20.19	67.54	20.07	80.25
39.80	156.52	40.38	169.29	39.80	179.13	40.38	173.22	39.80	139.00	40.03	163.43
59.99	242.60	59.99	250.49	59.99	266.23	59.99	253.46	59.99	214.36	59.99	245.43
79.60	325.71	79.60	330.70	79.60	334.74	79.60	336.62	79.60	290.69	79.60	323.69
99.79	411.76	99.79	413.84	99.79	420.84	99.79	418.79	99.79	368.96	99.79	406.84
119.98	500.72	119.98	500.89	119.98	507.92	119.98	503.89	119.98	449.19	119.98	492.52
99.79	417.63	99.79	421.65	99.79	425.72	99.79	423.65	99.79	369.92	99.79	411.72
79.60	332.46	79.60	342.40	79.60	344.50	79.60	341.45	79.60	293.58	79.60	330.88
59.99	255.16	59.99	264.12	59.99	257.40	59.99	261.19	59.99	220.15	59.99	251.60
39.80	165.10	39.80	184.86	39.80	176.17	39.80	181.91	39.80	145.76	39.80	170.76
20.19	81.01	22.50	101.71	20.19	85.15	20.19	96.79	20.19	76.28	20.65	88.19
40.38	166.08	40.38	178.01	39.80	166.38	39.80	177.03	39.80	144.78	40.03	166.45
60.57	251.14	60.57	259.20	60.57	253.47	60.57	264.09	59.99	219.15	60.45	249.41
79.60	336.20	79.60	335.47	79.60	335.65	79.60	342.35	79.60	295.46	79.60	329.03
99.79	409.51	99.79	417.61	99.79	421.74	100.37	425.50	99.79	369.82	99.90	408.83
121.13	506.25	120.55	506.60	119.98	509.77	119.98	506.68	119.98	449.[illegible]	120.32	495.67

LABEL IS 14YY

ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	AVERAGED ACTIONS &	STRAINS
19.00	70.48	20.73	61.68	23.03	94.86	20.15	101.69	20.15	90.01	20.61	83.74
40.30	158.53	40.30	132.13	40.88	175.06	39.73	202.42	39.73	182.98	40.19	170.22
60.46	243.63	59.88	200.60	59.88	256.25	59.88	305.10	59.88	276.95	59.99	256.50
79.46	330.67	79.46	275.91	79.46	347.19	79.46	402.89	79.46	371.90	79.46	345.71
100.76	426.49	99.61	354.14	100.18	442.04	99.61	499.69	99.61	470.77	99.95	438.62
119.76	512.51	120.33	437.26	119.76	526.13	119.76	598.44	119.76	569.66	119.87	528.80
98.46	426.46	99.61	356.09	99.61	443.01	99.61	509.43	99.61	477.66	99.38	442.53
77.73	339.42	79.46	277.86	79.46	356.96	79.46	419.47	79.46	389.62	79.11	356.67
59.88	267.05	59.30	201.57	59.30	268.95	59.88	329.49	59.88	303.[illegible]	59.65	274.11
39.73	176.08	39.73	129.20	39.73	187.78	39.73	229.75	39.73	210.53	39.73	186.67
20.15	91.96	20.15	63.64	20.15	100.73	20.15	129.03	20.15	107.74	20.15	98.62
39.73	174.89	39.73	129.16	39.73	181.88	39.73	218.98	39.73	197.76	39.73	180.54
59.88	259.04	59.88	204.45	59.88	263.05	60.46	317.73	59.88	289.77	59.99	266.81
79.46	344.07	80.61	278.78	79.46	352.03	79.46	410.62	79.46	384.71	79.69	354.04
99.61	429.10	99.61	354.07	99.61	441.99	99.61	506.43	99.61	478.69	99.61	442.06
119.76	519.00	119.76	438.16	119.76	532.91	119.76	602.25	119.76	574.65	119.76	533.39

LABEL IS 15YY

ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	AVERAGED ACTIONS &	STRAINS
20.13	58.75	20.13	93.01	20.13	149.76	20.13	100.85	20.13	57.80	20.13	92.03
39.69	121.36	39.69	206.48	39.69	303.34	39.69	203.57	39.69	123.37	39.69	191.62
59.82	191.80	60.39	319.01	59.82	443.20	59.82	304.31	59.82	196.77	59.93	291.02
79.95	271.01	79.95	432.49	79.95	572.29	79.95	408.03	79.95	274.08	79.95	391.57
100.08	369.77	100.08	544.01	100.08	692.56	99.50	509.73	100.08	355.30	99.96	494.27
120.21	480.24	119.63	644.78	119.63	805.00	119.63	611.46	119.63	440.44	119.75	596.39
98.93	402.97	100.08	564.56	100.08	711.10	99.50	520.49	100.08	360.23	99.73	511.87
79.95	332.54	79.37	465.76	79.95	618.21	79.95	426.59	79.95	288.92	79.83	426.38
59.24	256.25	59.24	357.18	59.82	492.00	59.24	329.75	59.82	214.47	59.47	329.93
39.69	190.74	39.69	251.54	39.69	359.09	39.69	235.85	39.69	145.70	39.69	236.43
18.41	110.56	20.13	123.37	20.13	221.13	20.13	142.91	20.13	78.42	19.79	135.28
39.69	174.13	41.41	236.86	41.99	357.09	39.69	229.99	39.69	141.76	40.49	227.83
59.82	243.56	60.39	340.58	59.82	468.60	59.82	325.87	59.82	212.50	59.93	318.22
80.52	319.81	79.95	447.21	79.95	588.88	79.95	424.69	79.95	290.80	80.06	414.28
100.08	402.91	100.08	552.87	100.08	706.22	100.08	519.59	100.08	366.18	100.08	509.55
119.63	488.95	119.63	653.65	119.63	812.79	119.63	619.39	119.63	449.37	119.63	604.83

LABEL IS 16YY

ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	AVERAGED ACTIONS &	STRAINS
20.17	93.01	20.17	111.61	20.17	148.84	20.17	152.69	20.17	107.68	20.17	122.76
39.76	193.94	40.34	202.61	42.65	309.29	39.76	300.36	39.76	222.12	40.46	243.66
59.93	269.97	59.93	289.63	59.93	421.72	59.93	444.03	59.93	335.55	59.93	352.18
80.10	367.66	80.10	387.35	80.10	544.87	80.10	567.13	80.10	443.10	80.10	462.02
99.70	457.50	99.70	482.12	99.70	662.12	99.70	688.23	99.70	548.68	99.70	567.73
120.44	565.82	119.87	585.64	119.87	784.21	119.87	804.40	119.87	659.14	119.98	679.84
99.70	479.79	99.70	502.55	99.70	687.41	99.70	708.61	99.70	576.[illegible]	99.70	590.88
80.10	400.62	80.10	416.52	80.10	592.59	80.10	617.73	80.10	490.[illegible]	80.10	503.49
59.93	314.63	59.36	333.43	59.93	485.06	59.93	512.19	59.93	403.96	59.82	409.85
39.76	227.71	39.76	248.41	39.76	370.70	39.76	399.82	39.76	305.20	39.76	310.37
19.59	141.81	19.02	149.70	20.17	237.77	20.17	267.92	20.17	198.55	19.82	199.15
40.92	240.56	39.76	237.69	40.92	352.17	39.76	374.46	39.76	280.74	40.23	297.13
59.93	320.72	59.93	323.70	59.93	460.66	59.93	485.83	59.93	375.60	59.93	393.30
80.10	405.69	80.10	415.56	80.10	569.12	80.10	600.12	80.10	473.39	80.10	492.77
99.70	486.74	99.70	501.54	99.70	679.50	99.70	707.54	99.70	574.10	99.70	589.88
119.87	581.42	119.87	596.28	119.87	795.71	119.87	821.75	119.87	678.70	119.87	694.77

TABLE C2 CONTINUED

ACTION T_1 (lb/in) AND MEAN STRAIN ϵ_y (micrstrain) VALUES AT EACH GAUGE POSITION (see fig 6.4.)

LABEL IS 17YY

y1&y2 ACTION	STRAIN	y3&y4 ACTION	STRAIN	y5&y6 ACTION	STRAIN	y7 & y8 ACTION	STRAIN	y9&y10 ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
19.62	66.51	20.20	88.04	20.20	75.31	20.20	56.76	20.20	67.50	20.09	70.82
40.98	139.87	40.98	186.85	40.40	158.47	39.83	119.41	39.83	135.97	40.40	148.11
60.03	205.40	60.03	274.91	60.03	239.67	60.61	191.84	60.03	203.48	60.14	223.06
79.65	270.93	79.65	359.05	79.65	324.79	79.65	257.44	79.65	269.04	79.65	296.25
99.85	340.37	99.85	446.12	99.85	403.07	99.85	325.96	99.85	340.46	99.85	371.20
119.48	409.81	119.48	529.28	120.06	484.28	119.48	394.49	119.48	413.85	119.59	446.34
99.28	343.33	99.85	453.01	99.85	408.01	99.85	330.92	99.85	339.55	99.74	374.97
79.65	274.89	79.65	372.83	79.65	328.80	79.65	258.56	79.65	276.00	79.65	302.22
60.03	211.35	59.45	284.83	60.03	259.36	58.87	188.14	60.03	206.59	59.68	230.06
39.83	139.03	39.25	195.83	39.83	174.27	39.83	126.55	39.83	137.16	39.71	154.56
20.20	71.46	20.20	104.83	20.20	89.14	20.20	65.77	20.20	71.58	20.20	80.56
39.83	135.07	39.83	186.02	39.83	167.39	39.83	126.42	39.83	138.10	39.83	150.60
60.03	204.51	60.03	275.05	60.03	248.59	60.03	196.97	60.03	206.60	60.03	226.33
79.65	272.99	79.65	356.25	79.65	327.84	79.65	264.45	79.65	276.07	79.65	299.52
99.85	344.39	99.85	442.35	99.85	408.08	99.85	334.93	99.85	347.48	99.85	375.45
120.06	417.75	119.48	527.48	119.48	487.35	119.48	402.53	119.48	419.90	119.59	450.99

LABEL IS 18YY

ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
19.64	76.32	20.21	66.53	20.21	68.50	20.21	73.38	20.21	84.14	20.10	73.77
39.85	164.38	40.43	138.96	41.59	146.82	40.43	148.76	39.85	164.39	40.43	152.66
60.07	251.47	62.96	220.17	60.07	215.34	60.07	221.18	60.07	244.64	60.64	230.56
79.70	332.67	79.70	277.90	79.70	288.75	80.28	291.63	79.70	322.90	79.82	302.77
99.92	417.78	99.92	351.27	99.92	365.07	99.92	351.27	99.92	401.14	99.92	377.30
119.56	503.87	120.13	424.63	120.13	441.38	119.56	435.41	119.56	477.42	119.79	456.54
99.92	436.33	99.92	356.13	99.92	372.86	99.92	356.17	99.92	404.[illegible]4	99.92	385.11
79.70	359.99	79.70	288.60	79.70	300.42	80.28	295.46	79.70	328.70	79.82	314.63
60.07	282.66	59.49	222.03	60.07	236.77	60.07	226.93	60.07	252.38	59.95	244.15
39.85	201.41	39.85	143.75	39.85	163.33	39.85	156.44	39.85	181.41	39.85	169.37
20.21	115.32	20.21	82.08	20.21	86.94	20.21	83.06	20.21	102.66	20.21	94.41
39.85	189.68	39.85	145.68	39.85	153.54	39.85	150.57	39.85	176.[illegible]4	39.85	163.10
60.07	270.88	60.64	218.07	60.07	225.96	60.07	221.02	60.07	248.46	60.18	236.88
79.70	348.16	79.70	284.58	80.28	301.30	80.28	295.35	79.70	327.69	79.94	311.42
99.92	426.41	99.92	357.94	99.92	372.71	99.92	363.81	99.92	407.89	99.92	385.75
119.56	504.64	119.56	429.33	119.56	446.08	119.56	436.16	119.56	483.19	119.56	459.88

LABEL IS 19YY

ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
19.56	60.65	20.13	78.28	20.13	94.86	20.71	105.63	20.13	78.27	20.13	83.54
39.69	127.20	39.69	169.33	40.84	215.23	39.69	216.24	39.69	149.74	39.92	175.55
59.82	195.67	59.24	262.35	59.24	317.00	59.82	330.77	59.82	223.20	59.59	266.40
80.52	275.98	79.95	363.21	79.95	425.63	79.95	445.3[illegible]	79.95	302.51	80.06	362.53
100.08	368.94	99.50	458.19	99.50	525.45	99.50	540.26	99.50	378.00	99.62	454.35
119.63	472.66	119.63	562.00	119.63	630.14	120.78	619.49	119.63	462.17	119.86	549.29
99.50	405.15	99.50	480.77	99.50	546.00	99.50	534.35	99.50	388.78	99.50	471.01
79.95	335.67	79.95	397.58	79.95	467.71	79.95	448.23	79.95	317.35	79.95	393.31
59.82	264.23	59.82	305.57	59.82	370.84	59.24	349.39	59.82	250.80	59.70	308.16
39.69	192.78	39.69	211.58	39.69	268.10	39.69	251.51	39.69	180.40	39.69	220.85
18.41	117.41	20.13	118.54	20.13	148.72	20.13	136.07	20.13	108.79	19.79	125.89
40.26	181.00	40.84	202.73	39.69	244.60	39.69	230.94	39.69	172.42	40.03	206.34
59.82	246.58	59.82	282.06	59.82	344.42	59.82	330.78	59.82	240.[illegible]1	59.82	288.77
79.95	316.05	79.95	378.03	79.95	448.14	79.95	429.64	79.95	313.48	79.95	377.07
99.50	391.41	99.50	468.12	99.50	543.06	99.50	523.62	99.50	387.[illegible]3	99.50	462.83
119.63	472.63	119.63	565.09	119.63	640.92	119.63	615.64	119.63	467.29	119.63	552.31

LABEL IS 20YY

ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	ACTION	STRAIN	AVERAGED ACTIONS & STRAINS	
19.00	104.68	20.15	113.51	20.15	118.44	20.15	104.69	20.15	81.24	19.92	104.51
39.72	218.18	40.30	244.65	39.72	251.50	39.72	221.08	39.72	172.25	39.84	221.53
59.87	333.66	59.87	355.25	59.87	379.65	59.87	345.29	59.87	265.21	59.87	335.81
80.02	444.29	81.75	474.69	80.02	484.31	80.02	452.87	80.02	360.13	80.37	443.26
99.59	539.25	99.59	559.89	99.59	581.14	101.32	556.53	99.59	444.29	99.94	536.22
119.74	641.09	119.74	658.79	120.89	680.89	119.74	641.60	119.74	531.40	119.97	630.75
99.59	573.58	99.59	587.37	99.59	606.54	99.59	570.21	99.59	460.96	99.59	559.73
80.02	500.17	80.02	516.91	80.02	534.15	80.02	496.86	80.02	397.37	80.02	489.09
59.87	422.82	59.30	432.73	59.87	457.83	59.87	422.52	59.87	323.99	59.76	411.98
39.72	338.61	39.72	348.53	39.72	371.73	39.72	340.37	39.72	256.45	39.72	331.14
17.85	232.81	20.15	236.86	19.57	265.10	20.15	237.73	20.15	170.30	19.57	228.56
39.72	317.88	40.30	321.04	39.72	347.24	39.72	314.94	39.72	234.87	39.84	307.20
59.87	400.09	59.87	408.18	59.87	434.27	59.87	398.03	59.87	308.28	59.87	389.77
80.02	480.34	80.02	494.36	80.02	521.29	80.02	486.02	80.02	386.57	80.02	473.71
99.59	557.69	100.17	576.63	99.59	604.39	99.59	568.14	99.59	459.47	99.71	553.36
119.74	644.81	119.74	656.94	119.74	687.49	119.74	649.28	119.74	539.25	119.59	635.55

TABLE C2 CONTINUED

ACTION T_2 (lb/in) AND MEAN STRAIN ε_y (micrstrain) VALUES AT EACH GAUGE POSITION (see fig 6.4.)

LABEL IS 21YY

y1 & y2 ACTION	y1 & y2 STRAIN	y3 & y4 ACTION	y3 & y4 STRAIN	y5 & y6 ACTION	y5 & y6 STRAIN	y7 & y8 ACTION	y7 & y8 STRAIN	y9 & y10 ACTION	y9 & y10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
20.13	54.80	20.13	73.43	20.13	75.36	20.13	64.59	20.13	56.75	20.13	64.99
39.68	114.45	40.26	152.74	39.68	154.63	39.68	134.08	39.68	114.50	39.80	134.08
59.81	173.14	60.96	229.10	59.81	233.90	59.81	205.53	59.81	175.17	60.04	203.37
79.94	234.60	79.94	296.66	79.94	311.23	79.94	276.98	79.94	219.20	79.94	267.77
99.49	294.48	99.49	368.15	99.49	386.57	99.49	345.47	99.49	297.49	99.49	330.43
119.62	357.10	119.62	441.58	119.62	463.87	119.62	420.82	119.62	362.[illegible]7	119.62	409.09
99.49	306.19	99.49	374.05	99.49	390.48	98.34	347.42	99.49	298.43	99.26	343.31
79.94	237.72	79.94	306.50	79.94	319.03	79.94	285.76	79.94	238.71	79.94	277.54
59.81	179.98	59.23	233.06	59.81	244.63	59.81	215.27	59.81	174.10	59.69	209.41
39.68	120.29	39.68	153.77	39.68	167.31	39.68	146.75	39.68	114.41	39.68	140.50
19.55	64.53	19.55	72.49	20.13	85.10	20.13	75.31	20.13	51.80	19.90	69.85
39.68	119.31	40.83	150.80	39.68	160.44	39.68	140.86	39.68	112.45	39.91	136.77
59.81	178.98	59.91	223.24	59.81	235.79	59.81	212.30	59.81	173.10	59.81	204.68
79.94	238.67	79.94	291.77	79.94	315.04	79.94	279.83	79.94	234.73	79.94	272.01
99.49	298.35	99.49	360.31	99.49	386.46	99.49	348.31	99.49	294.41	99.49	337.57
119.62	360.95	119.62	437.66	119.62	462.77	119.62	420.70	119.62	358.97	119.62	408.21

LABEL IS 22YY

y1 & y2 ACTION	y1 & y2 STRAIN	y3 & y4 ACTION	y3 & y4 STRAIN	y5 & y6 ACTION	y5 & y6 STRAIN	y7 & y8 ACTION	y7 & y8 STRAIN	y9 & y10 ACTION	y9 & y10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
20.17	72.37	20.17	50.84	20.17	46.98	20.17	62.59	20.17	81.2[illegible]	20.17	62.80
40.34	152.55	39.76	109.51	40.34	104.71	39.76	122.26	39.76	161.43	39.99	130.09
61.08	226.86	60.50	177.01	59.93	161.48	59.93	182.92	59.93	237.76	60.27	197.21
80.09	296.26	80.09	235.70	80.09	219.24	80.09	243.58	80.09	314.[illegible]9	80.09	261.78
99.69	367.63	99.69	298.29	99.69	276.02	99.69	305.22	99.69	391.41	99.69	327.71
120.43	442.91	119.85	364.79	119.85	337.70	119.85	366.87	119.85	469.72	119.97	396.40
99.69	378.38	99.69	300.24	99.69	280.95	99.69	306.22	99.69	395.37	99.69	332.23
80.09	312.88	80.09	240.58	80.09	224.21	80.09	255.37	80.09	323.96	80.09	271.40
59.93	241.51	59.93	180.94	59.93	163.57	59.93	196.70	59.93	297.44	59.93	216.03
39.76	168.20	39.76	117.39	39.18	106.84	39.18	137.06	39.76	221.14	39.53	150.13
18.44	83.16	20.17	55.80	20.17	53.98	20.17	79.34	20.17	140.49	19.82	82.63
40.91	159.43	39.76	111.55	39.76	107.81	39.76	138.04	39.76	215.27	39.99	146.42
60.50	231.80	59.93	176.12	59.93	166.55	59.93	194.81	59.93	291.63	60.04	212.18
81.82	309.04	80.09	237.76	80.09	226.28	80.09	256.47	80.09	369.96	80.44	279.90
100.26	372.59	99.69	298.41	99.69	283.08	99.69	316.17	99.69	441.43	99.80	342.33
119.85	440.06	119.85	363.95	119.85	345.76	119.85	381.75	119.85	518.78	119.85	410.06

LABEL IS 23YY

y1 & y2 ACTION	y1 & y2 STRAIN	y3 & y4 ACTION	y3 & y4 STRAIN	y5 & y6 ACTION	y5 & y6 STRAIN	y7 & y8 ACTION	y7 & y8 STRAIN	y9 & y10 ACTION	y9 & y10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
20.12	74.37	20.12	46.04	20.12	66.59	20.12	77.33	20.12	66.56	20.12	66.18
39.67	149.70	40.24	97.92	39.67	133.12	39.67	145.82	39.67	141.90	39.78	133.69
59.79	222.08	60.36	154.68	59.79	203.55	59.79	211.37	59.79	219.19	59.90	202.17
79.91	291.50	79.91	212.42	79.91	274.95	79.91	283.77	79.91	293.55	79.91	271.24
100.03	363.86	100.03	275.05	100.03	346.33	100.03	350.27	100.03	369.83	100.03	341.07
119.57	432.31	120.15	338.67	120.15	419.67	119.57	417.74	119.57	444.14	119.80	410.50
99.45	374.56	100.03	284.84	100.03	356.07	100.03	359.04	100.03	380.53	99.9[illegible]	351.01
79.91	312.91	79.33	227.10	79.33	286.56	79.91	292.50	79.91	313.[illegible]2	79.68	286.82
59.79	249.31	59.79	172.29	58.64	220.07	59.79	230.86	59.79	245.49	59.56	223.60
39.67	175.93	39.67	115.52	39.67	155.49	39.09	163.35	39.67	174.[illegible]6	39.55	156.87
18.40	89.86	20.12	59.70	20.12	85.08	20.12	96.84	20.12	95.82	19.78	85.46
39.67	158.32	39.67	109.61	39.67	145.70	39.67	159.42	39.67	163.30	39.67	147.27
59.79	226.75	59.79	164.42	59.79	210.24	60.36	226.9[illegible]	59.79	230.78	59.90	211.82
79.91	296.16	79.91	222.16	79.91	277.70	79.91	292.41	79.91	299.25	79.91	277.53
100.03	361.65	100.03	281.85	100.03	345.14	100.03	357.91	100.03	369.64	100.03	343.24
119.57	435.98	119.57	339.60	119.57	411.62	119.57	421.45	119.57	440.[illegible]2	119.57	409.73

LABEL IS 24YY

y1 & y2 ACTION	y1 & y2 STRAIN	y3 & y4 ACTION	y3 & y4 STRAIN	y5 & y6 ACTION	y5 & y6 STRAIN	y7 & y8 ACTION	y7 & y8 STRAIN	y9 & y10 ACTION	y9 & y10 STRAIN	AVERAGED ACTIONS	AVERAGED STRAINS
20.16	109.66	20.16	78.28	20.16	89.05	20.15	103.73	20.16	115.48	20.16	99.24
39.74	231.03	40.31	163.36	39.74	179.06	40.31	199.63	39.74	221.17	39.97	198.65
59.32	332.85	59.32	241.63	59.32	260.26	59.90	278.85	59.90	309.24	59.55	284.57
80.05	435.63	80.05	326.71	80.05	347.30	80.05	359.06	80.05	402.21	80.05	374.19
99.63	527.65	99.63	407.88	99.63	426.52	99.63	435.37	99.63	484.42	99.63	456.37
119.79	626.51	119.79	493.92	119.79	508.66	119.79	511.66	119.79	567.62	119.79	541.67
99.63	563.88	99.63	435.24	99.63	449.00	99.63	451.99	99.63	504.[illegible]2	99.63	480.83
80.05	495.37	80.05	371.67	80.05	391.29	80.05	387.42	80.05	437.48	80.05	416.64
59.32	422.91	59.32	298.31	59.32	322.81	59.32	316.99	59.32	361.15	59.32	344.43
37.43	344.55	39.74	234.73	39.74	261.17	39.74	248.48	39.74	286.77	39.28	275.14
20.73	271.93	20.16	159.42	20.16	186.82	20.16	166.31	20.16	198.69	20.27	196.63
40.89	346.20	39.74	218.09	39.74	244.52	39.74	230.85	39.74	271.[illegible]8	39.97	262.15
59.32	412.73	59.90	282.61	59.32	305.14	59.32	299.31	59.32	344.47	59.43	328.85
80.63	495.87	80.05	353.01	80.05	372.62	80.05	368.75	80.05	422.77	80.17	402.60
99.63	568.22	99.63	421.45	99.63	438.12	99.63	437.19	99.63	496.16	99.63	472.23
119.79	644.49	119.79	496.71	119.79	509.49	119.79	507.59	119.79	574.43	119.79	546.54

TABLE C2 CONTINUED - POISSON RATIO MEASUREMENTS

STRAINS ARE MEANS OF THOSE OBSERVED AT POSITIONS x5,x6 AND y5,y6.

LABEL	1YX		1XY		2YX		2XY		3YX		3XY		4YX		4XY	
WIDTH	7.524		7.695		7.586		7.608		7.616		7.650		7.652		7.641	
GRADE	0.5427		0.5427		0.6459		0.6459		0.7223		0.7223		0.7845		0.9765	
	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y
	-41.23	14.7	-80.62	36.2	-39.72	5.9	-80.38	31.4	-39.56	5.9	-79.93	-1.0	-40.54	8.8	-80.03	-10.8
	-80.10	41.1	-160.09	70.5	-79.44	11.7	-159.59	54.8	-80.29	11.7	-159.87	12.7	-79.91	18.6	-160.06	1.9
	-120.14	65.6	-239.55	101.8	-120.33	20.5	-239.96	69.4	-119.86	16.6	-239.80	26.5	-120.45	27.4	-240.09	16.6
	-160.19	90.0	-320.17	134.1	-160.05	29.3	-320.34	92.9	-160.58	23.5	-319.74	46.1	-159.83	35.2	-320.12	34.2
	-200.24	112.5	-399.64	162.4	-199.77	39.1	-399.55	115.3	-200.15	32.3	-399.67	67.7	-200.36	40.1	-400.14	52.8
	-240.29	133.1	-480.26	192.8	-239.49	47.9	-479.93	136.8	-239.71	41.1	-479.61	88.2	-239.74	47.0	-480.17	75.4
	-200.24	113.5	-399.64	164.4	-199.77	38.1	-399.55	118.2	-200.15	32.3	-399.67	70.6	-200.36	41.1	-400.14	58.7
	-160.19	90.1	-320.17	136.0	-160.05	31.2	-320.34	98.7	-160.58	23.5	-319.74	53.0	-159.83	33.3	-320.12	42.1
	-120.14	75.4	-239.55	107.6	-120.33	24.4	-239.96	75.2	-119.86	13.7	-239.80	37.4	-120.45	25.4	-240.09	26.4
	-80.10	38.2	-160.09	79.3	-79.44	16.6	-159.59	49.9	-80.29	7.8	-159.87	23.6	-79.91	18.6	-160.06	9.8
	-40.05	7.9	-79.47	49.0	-39.72	12.7	-80.38	29.4	-39.56	2.9	-79.93	9.9	-40.54	10.8	-80.03	-11.7
	-80.10	36.2	-160.09	80.3	-79.44	18.6	-159.59	53.8	-80.29	8.8	-159.87	22.6	-79.91	19.6	-160.06	3.0
	-120.14	60.7	-239.55	109.6	-120.33	24.4	-239.96	75.3	-119.86	13.7	-239.80	40.2	-120.45	27.4	-240.09	20.6
	-160.19	87.1	-320.17	140.0	-160.05	33.2	-320.34	96.8	-160.58	21.5	-319.74	56.9	-159.83	36.2	-320.12	37.2
	-200.24	106.7	-399.64	167.3	-199.77	41.0	-399.55	119.2	-200.15	28.4	-399.67	73.5	-200.36	43.0	-400.14	57.8
	-240.29	127.2	-480.26	196.7	-239.49	49.8	-479.93	138.7	-239.71	39.2	-479.61	92.2	-239.74	47.9	-480.17	75.4

LABEL	5YX		5XY		6YX		6XY		7YX		7XY		8YX		8XY	
WIDTH	7.691		7.689		7.674		7.652		7.692		7.639		7.647		7.623	
GRADE	0.8400		0.8400		0.8776		0.8776		0.9167		0.9167		0.9517		0.9517	
	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y
	-40.33	8.8	-79.54	44.9	-39.26	29.4	-79.91	24.4	-43.78	25.5	-80.06	-0.2	-40.56	4.9	-80.22	11.7
	-79.51	19.6	-160.23	75.3	-78.53	44.1	-159.83	44.9	-79.50	35.3	-160.12	20.2	-79.97	7.8	-160.44	24.4
	-119.84	33.3	-239.77	101.7	-118.95	56.8	-239.74	60.6	-119.82	47.0	-240.18	33.8	-120.53	10.8	-239.49	34.2
	-160.17	44.0	-320.46	125.2	-158.21	63.6	-319.66	74.3	-160.15	55.8	-320.24	48.5	-159.93	12.7	-319.71	44.9
	-199.35	51.8	-400.00	147.8	-197.48	72.5	-399.57	85.1	-199.32	60.8	-400.30	61.2	-200.49	16.7	-399.93	58.7
	-239.68	62.6	-479.54	167.4	-236.74	79.3	-479.48	96.9	-239.65	69.6	-480.36	72.9	-239.90	18.6	-480.14	71.4
	-199.35	52.8	-400.00	150.7	-197.48	72.5	-399.57	86.1	-199.32	60.8	-400.30	64.1	-200.49	16.7	-399.93	65.6
	-160.17	44.0	-320.46	132.1	-158.21	65.6	-319.66	76.3	-160.15	54.9	-320.24	52.3	-159.93	14.7	-319.71	57.7
	-119.84	31.3	-239.77	111.5	-118.95	57.8	-239.74	63.5	-119.82	45.1	-240.18	41.6	-120.53	12.7	-239.49	49.8
	-79.51	21.5	-160.23	83.0	-78.53	49.0	-159.83	51.7	-79.50	33.3	-160.12	30.9	-79.97	11.8	-160.44	42.0
	-40.33	8.9	-79.54	62.5	-39.26	39.2	-79.91	39.0	-40.33	22.6	-80.06	22.2	-40.56	10.8	-80.22	32.2
	-79.51	17.6	-160.23	88.0	-78.53	52.9	-159.83	52.7	-79.50	34.3	-160.12	35.9	-79.97	13.7	-160.44	43.0
	-119.84	29.3	-239.77	111.5	-118.95	62.7	-239.74	65.5	-119.82	47.0	-240.18	48.5	-120.53	17.6	-239.49	50.8
	-160.17	41.1	-320.46	132.1	-158.21	72.5	-319.66	84.1	-160.15	48.0	-320.24	59.2	-159.93	20.6	-319.71	59.6
	-199.35	50.9	-400.00	153.6	-197.48	79.3	-399.57	89.0	-199.32	65.6	-400.30	70.0	-200.49	24.5	-399.93	68.5
	-239.68	60.6	-479.54	172.3	-236.74	89.1	-479.48	98.8	-239.65	74.5	-480.36	80.7	-239.90	27.4	-480.14	79.3

LABEL	9YX		9XY		10YX		10XY		11YX		11XY		12YX		12XY	
WIDTH	7.655		7.627		7.676		7.616		7.690		7.640		7.667		7.617	
GRADE	0.9889		0.9889		1.0220		1.0220		1.0544		1.0544		1.0952		1.0952	
	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y
	-40.52	7.8	-80.18	20.5	-40.41	6.8	-80.29	17.6	-40.34	2.9	-80.04	24.4	-40.46	5.9	-80.28	17.6
	-79.88	14.7	-160.35	33.1	-79.66	14.7	-160.58	31.3	-79.52	6.9	-160.08	52.9	-79.76	9.8	-159.40	32.3
	-120.40	21.6	-240.53	44.9	-120.07	19.6	-239.71	43.1	-119.85	9.8	-240.12	70.5	-120.21	12.7	-239.68	45.0
	-159.77	29.4	-319.54	56.6	-160.48	23.5	-320.00	52.9	-160.19	12.7	-320.16	85.2	-159.52	15.7	-319.96	56.8
	-200.29	34.3	-399.72	67.4	-199.74	27.4	-400.29	64.6	-199.37	15.7	-400.20	101.9	-199.97	17.6	-400.24	69.6
	-239.65	40.2	-479.89	81.1	-240.15	31.3	-480.59	74.4	-239.71	18.6	-480.24	117.5	-240.43	19.6	-479.36	82.3
	-200.29	38.2	-399.72	71.3	-199.74	26.4	-400.29	62.7	-159.37	14.7	-400.20	103.8	-159.97	16.6	-400.24	73.5
	-159.77	31.3	-319.54	62.5	-160.48	24.5	-320.00	52.9	-160.19	12.7	-320.16	90.1	-159.52	13.7	-319.96	63.7
	-120.40	26.4	-240.53	55.6	-120.07	20.5	-239.71	43.1	-119.85	9.8	-240.12	76.3	-120.21	9.8	-239.68	52.9
	-79.88	22.5	-160.35	46.8	-79.66	15.7	-160.58	33.3	-79.52	6.9	-160.08	58.7	-79.76	7.8	-159.40	41.2
	-40.52	17.6	-80.18	39.0	-40.41	11.7	-80.29	21.5	-40.34	3.9	-80.04	41.0	-40.46	3.9	-80.28	27.5
	-79.88	24.5	-160.35	47.8	-79.66	17.6	-160.58	35.2	-79.52	7.8	-160.08	63.6	-79.76	7.8	-159.40	42.1
	-120.40	30.4	-240.53	56.6	-120.07	22.5	-239.71	48.0	-119.85	10.8	-240.12	82.2	-120.21	11.7	-239.68	53.9
	-159.77	35.3	-319.54	67.4	-160.48	27.4	-320.00	58.8	-160.19	14.7	-320.16	98.9	-159.52	14.7	-319.96	66.6
	-200.29	41.1	-399.72	77.2	-199.74	31.3	-400.29	69.5	-199.37	17.6	-400.20	113.6	-199.97	16.6	-400.24	77.4
	-239.65	47.0	-479.89	87.9	-240.15	36.2	-480.59	79.3	-239.71	20.6	-480.24	128.3	-240.43	20.6	-479.36	89.2

TABLE C2 CONTINUED - POISSON RATIO MEASUREMENTS

STRAINS ARE MEANS OF THOSE OBSERVED AT POSITIONS x5, x6 AND y5, y6.

LABEL	13YX		13XY		14YX		14XY		15YX		15XY		16YX		16XY	
WIDTH	7.674		7.626		7.678		7.607		7.688		7.646		7.677		7.660	
GRADE	1.1283		1.1283		1.1715		1.1715		1.2129		1.2129		1.2576		1.2576	
	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y
	-40.42	8.8	-80.19	26.4	-40.40	2.0	-80.39	8.9	-40.35	2.0	-79.98	23.4	-40.40	7.8	-79.83	-2.0
	-79.68	17.6	-160.37	47.9	-79.64	4.9	-159.61	18.7	-79.54	6.9	-159.95	41.0	-79.65	10.8	-159.66	1.0
	-120.10	23.5	-239.40	63.5	-120.04	7.8	-239.99	29.4	-119.89	11.8	-239.93	54.7	-120.06	15.7	-239.49	7.8
	-159.37	29.4	-319.58	78.2	-160.44	10.8	-320.38	39.2	-160.23	17.7	-319.91	70.4	-160.46	18.6	-319.32	14.7
	-199.79	35.2	-399.77	90.9	-199.69	11.8	-399.60	49.0	-200.58	21.6	-399.88	86.0	-199.71	20.5	-399.15	21.5
	-240.21	42.1	-479.96	103.6	-240.08	15.7	-479.99	59.8	-239.77	25.5	-479.86	101.7	-240.12	24.5	-478.98	30.3
	-199.79	37.2	-399.77	93.8	-199.69	12.8	-399.60	50.0	-200.58	21.6	-399.88	91.9	-199.71	22.5	-399.15	29.4
	-159.37	33.3	-319.58	81.1	-160.44	11.8	-320.38	40.2	-160.23	16.7	-319.91	79.2	-160.46	19.6	-319.32	26.4
	-120.10	27.4	-239.40	68.4	-120.04	9.8	-239.99	30.4	-119.89	11.8	-239.93	68.5	-120.06	17.6	-239.49	23.5
	-79.68	23.5	-160.37	52.8	-79.64	6.9	-159.61	19.7	-79.54	5.9	-159.95	54.7	-79.65	15.7	-159.66	20.5
	-40.42	15.6	-80.19	35.2	-40.40	7.8	-80.39	11.8	-40.35	-17.7	-79.98	40.0	-40.40	12.7	-79.83	17.6
	-79.68	23.5	-160.37	52.8	-79.64	9.8	-159.61	23.6	-79.54	5.9	-159.95	61.6	-79.65	17.6	-159.66	17.6
	-120.10	29.3	-239.40	69.4	-120.04	11.8	-239.99	33.4	-119.89	11.5	-239.93	77.3	-120.06	20.5	-239.49	22.5
	-159.37	35.2	-319.58	83.1	-160.44	12.7	-320.38	43.2	-160.23	17.6	-319.91	91.9	-160.46	23.5	-319.32	25.4
	-199.79	40.1	-399.77	96.8	-199.69	15.7	-399.60	52.0	-200.58	23.5	-399.88	103.7	-199.71	27.4	-399.15	30.3
	-240.21	46.9	-479.96	107.5	-240.08	18.6	-479.99	60.8	-239.77	27.4	-479.86	115.4	-240.12	30.3	-478.98	35.2

LABEL	17YX		17XY		18YX		18XY		19YX		19XY		20YX		20XY	
WIDTH	7.664		7.596		7.658		7.581		7.688		7.666		7.676		7.639	
GRADE	1.3089		1.3089		1.3711		1.3711		1.4248		1.4248		1.4691		1.4691	
	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y
	-40.47	4.9	-80.50	1.9	-40.50	2.9	-79.49	4.8	-40.35	6.9	-79.77	18.7	-40.41	3.9	-80.05	7.8
	-79.79	10.8	-159.84	12.7	-79.85	3.9	-160.16	9.7	-79.54	12.7	-159.54	21.7	-79.66	4.9	-160.10	16.7
	-120.26	15.7	-240.34	23.4	-120.36	6.8	-239.65	15.6	-119.89	16.7	-240.46	24.7	-120.07	7.8	-240.15	27.4
	-159.58	21.6	-319.68	33.2	-159.70	7.8	-320.31	21.5	-160.23	20.6	-320.23	28.6	-160.48	9.8	-320.20	35.2
	-200.05	25.5	-400.18	43.0	-200.21	9.8	-399.80	28.3	-199.43	24.5	-400.00	33.6	-199.74	11.7	-400.25	45.0
	-239.37	31.4	-479.52	50.8	-239.55	10.7	-479.30	35.2	-239.77	28.4	-479.76	39.5	-240.15	13.7	-480.30	54.8
	-200.05	27.4	-400.18	43.0	-200.21	10.7	-399.80	30.3	-199.43	24.5	-400.00	34.6	-199.74	10.8	-400.25	47.0
	-159.58	22.5	-319.68	33.2	-159.70	9.8	-320.31	24.4	-160.23	20.6	-320.23	29.7	-160.48	9.8	-320.20	38.1
	-120.26	18.6	-240.34	25.4	-120.36	8.8	-239.65	19.5	-119.89	16.7	-240.46	25.7	-120.07	7.8	-240.15	29.3
	-79.79	13.7	-159.84	14.6	-79.85	7.8	-160.16	14.6	-79.54	12.7	-159.54	21.8	-79.66	5.9	-160.10	22.4
	-40.47	8.8	-80.50	5.8	-40.50	7.8	-79.49	9.7	-40.35	9.8	-79.77	20.7	-40.41	3.9	-80.05	14.6
	-79.79	13.7	-159.84	15.6	-79.85	9.8	-160.16	14.6	-79.54	15.7	-159.54	23.7	-79.66	6.9	-160.10	24.4
	-120.26	19.6	-240.34	26.4	-120.36	10.8	-239.65	20.5	-119.89	20.6	-240.46	28.6	-120.07	9.8	-240.15	34.2
	-159.58	24.5	-319.68	36.2	-159.70	11.7	-320.31	26.4	-160.23	25.5	-320.23	32.6	-160.48	11.7	-320.20	43.0
	-200.05	28.4	-400.18	45.0	-200.21	13.7	-399.80	33.2	-199.43	29.4	-400.00	38.5	-199.74	13.7	-400.25	51.9
	-239.37	34.3	-479.52	54.8	-239.55	15.6	-479.30	38.1	-239.77	32.3	-479.76	41.4	-240.15	15.7	-480.30	61.6

LABEL	21YX		21XY		22YX		22XY		23YX		23XY		24YX		24XY	
WIDTH	7.684		7.664		7.672		7.661		7.693		7.660		7.674		7.682	
GRADE	1.5342		1.5342		1.6048		1.6048		1.6808		1.6808		1.7979		1.7979	
	T_2/t	ε_x	T_1/t	$\varepsilon_y T$ /	T_2/t	$\varepsilon_x T$	T_1/t	$\varepsilon_y T$	T_2/t	ε_x	T_1/t	ε_y	T_2/t	ε_x	T_1/t	ε_y
	-40.37	5.9	-79.79	15.7	-40.43	4.9	-79.82	10.7	-40.32	1.0	-79.83	1.9	-40.42	2.9	-79.60	2.9
	-79.58	10.8	-159.58	28.5	-79.71	9.8	-159.64	21.4	-79.49	2.0	-159.66	0.9	-79.68	4.9	-160.36	7.8
	-119.95	16.6	-240.52	38.3	-120.14	12.7	-239.46	32.2	-119.81	4.9	-239.49	5.8	-118.95	5.9	-239.96	15.7
	-160.32	21.5	-320.31	46.1	-160.57	15.7	-319.28	40.0	-160.13	6.9	-320.48	10.7	-160.52	5.9	-319.56	19.6
	-199.53	25.5	-400.10	53.9	-199.84	21.5	-400.26	49.9	-200.45	8.8	-400.31	14.6	-199.79	6.8	-400.32	25.5
	-239.90	29.4	-479.89	62.7	-240.27	24.5	-480.08	57.7	-239.62	10.8	-480.14	20.4	-240.21	7.8	-479.92	30.4
	-199.53	25.5	-400.10	55.9	-199.84	23.5	-400.26	49.8	-200.45	9.8	-400.31	16.5	-199.79	7.8	-400.32	29.4
	-160.32	22.5	-320.31	51.0	-160.57	23.5	-319.28	42.0	-160.13	8.8	-320.48	11.6	-160.52	7.8	-319.56	26.5
	-119.95	18.6	-240.52	43.2	-120.14	23.5	-239.46	33.2	-119.81	8.8	-239.49	8.7	-118.95	8.8	-239.96	23.5
	-79.58	14.7	-159.58	34.4	-79.71	23.5	-159.64	24.4	-79.49	7.8	-159.66	5.8	-79.68	9.8	-160.36	20.6
	-40.37	10.8	-79.79	26.5	-40.43	20.6	-79.82	15.6	-40.32	6.9	-79.83	4.8	-40.42	10.8	-79.60	16.6
	-79.58	15.7	-159.58	37.3	-79.71	24.5	-159.64	29.3	-79.49	7.8	-159.66	8.7	-79.68	11.7	-160.36	22.5
	-119.95	19.6	-240.52	46.1	-120.14	26.4	-239.46	39.0	-119.81	8.8	-239.49	12.6	-118.95	12.7	-239.96	27.4
	-160.32	23.5	-320.31	54.9	-160.57	29.4	-319.28	48.9	-160.13	9.8	-320.48	17.5	-160.52	12.7	-319.56	29.4
	-199.53	27.4	-400.10	61.8	-199.84	29.4	-400.26	57.7	-200.45	11.7	-400.31	21.4	-199.79	13.7	-400.32	33.3
	-239.90	31.3	-479.89	67.7	-240.27	33.3	-480.08	65.5	-239.62	13.7	-480.14	27.3	-240.21	14.7	-479.92	37.2

TABLE C3 DATA FROM SHEAR TESTS ON MODEL ELEMENTS

ACTION S/t (psi) AND STRAIN γ_{xy} (microstrain) VALUES AT EACH INCREMENT

ELEMENT NO 1SS MODULUS 0.5427
GLUED AND NAILED

ACTION S/T	20.0	40.0	60.0	80.0	100.0	120.0	100.0	80.0	60.0	40.0	20.0	40.0	60.0	80.0	100.0
ACTION S/T	120.0														
STRAIN GXY	196.0	409.0	549.7	711.5	973.8	1165.8	990.9	783.9	561.9	368.8	129.6	349.7	546.7	784.9	934.6
	1203.0														

ELEMENT NO 2SS MODULUS 0.6459
NAILS IN PATTERN 3

GAUGES CLIPPED IN PLACE IN TENSION DIRECTION ONLY

ACTION S/T	1.6	3.2	6.4	10.4	13.6	14.0	12.0	10.4	6.4	4.8	1.6	4.8	7.2	9.6	12.0
ACTION S/T	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.4	32.8	36.0	0.0			
STRAIN GXY	6.0	20.1	170.6	584.1	1150.2	1174.3	1168.2	1156.2	1112.0	1089.9	1007.6	1029.7	1067.8	1106.0	1164.2
STRAIN GXY	1220.4	1658.0	2179.9	2734.0	3416.6	4089.1	4878.0	5741.2	6897.5	8114.1	10069.4	6973.9			

ELEMENT NO 3SS MODULUS 0.7223
NAILS IN PATTERN 2

ACTION S/T	1.6	3.2	4.8	8.0	11.2	13.6	11.2	8.0	4.8	1.6	0.0	2.4	4.8	7.2	10.4
ACTION S/T	13.6	17.6	21.6	25.6	29.6	33.6	21.6	13.6	6.4	0.0					
STRAIN GXY	4.0	30.1	82.3	258.9	576.0	853.0	843.0	790.8	730.6	638.3	576.1	584.1	622.2	670.4	752.7
STRAIN GXY	865.0	1752.3	3075.1	4857.7	7535.6	10952.3	10825.9	10486.7	9810.3	8555.8					

ELEMENT NO 4SS MODULUS 0.9765
NAILS IN PATTERN 1 CUT FROM TORSION ELEMENT

ACTION S/T	1.6	3.2	7.2	8.0	9.6	10.4	8.0	5.6	3.6	1.6	0.0	2.4	4.0	5.6	8.0
ACTION S/T	9.6	10.4	12.8	14.4											
STRAIN GXY	6.0	16.1	271.0	445.6	1051.9	1531.7	1527.6	1513.6	1497.5	1477.4	1459.3	1467.4	1479.4	1493.5	1513.6
STRAIN GXY	1537.7	1561.8	3709.8	6998.0											

ELEMENT NO 5SS MODULUS 0.8400

ACTION S/T	20.0	40.0	60.0	80.0	100.0	120.0	100.0	80.0	60.0	40.0	20.0	0.0	20.0	40.0	60.0
ACTION S/T	80.0	100.0	120.0												
STRAIN GXY	178.6	453.7	731.0	1010.2	1317.8	1608.5	1449.9	1146.6	957.9	666.6	367.4	92.4	259.0	515.9	781.0
STRAIN GXY	1060.1	1369.4	1634.6												

ELEMENT NO 6SS MODULUS 0.8776

ACTION S/T	2.0	4.0	6.0	8.0	11.6	14.0	11.2	8.8	6.8	4.4	2.0	0.0	2.0	4.4	6.4
ACTION S/T	8.8	10.8	13.2	14.8	16.4	18.4	23.2								
STRAIN GXY	16.0	50.1	116.3	258.8	666.2	1051.6	1025.6	997.5	967.4	929.2	865.0	808.9	814.9	839.0	867.1
STRAIN GXY	917.3	969.4	1029.6	1121.9	1633.8	1983.1	3695.5								

ELEMENT NO 7SS MODULUS 0.9167

ACTION S/T	2.0	4.0	6.0	8.0	10.0	11.6	9.6	7.6	5.6	3.6	1.6	0.0	2.0	4.0	6.4
ACTION S/T	8.0	10.0	11.6	13.6	16.0	19.2	23.2								
STRAIN GXY	22.1	60.2	138.4	310.9	614.0	1001.3	987.3	967.2	939.2	905.1	857.0	800.8	816.9	841.0	877.1
STRAIN GXY	907.1	957.3	1015.4	1475.0	2416.4	4233.0	7220.0								

ELEMENT NO 8SS MODULUS 0.9517

ACTION S/T	2.0	4.0	6.0	8.0	8.8	9.6	8.0	6.4	4.8	3.2	1.6	0.0	1.6	3.2	4.8
ACTION S/T	6.4	8.0	9.6	11.2	12.8	14.4	16.0								
STRAIN GXY	-26.1	3.8	90.2	395.3	620.1	929.2	923.2	903.1	875.0	840.9	798.7	750.6	762.6	770.7	790.7
STRAIN GXY	812.8	848.9	893.1	1441.1	2334.3	4080.7	7134.0								

TABLE C3 CONTINUED

ACTION S/t (psi) AND STRAIN γ_{xy} (microstrain) VALUES AT EACH INCREMENT

ELEMENT NO 9SS MODULUS 0.9889

ACTION S/T	20.0	40.0	60.0	80.0	100.0	120.0	100.0	80.0	60.0	40.0	20.0	0.0	20.0	40.0	60.0
ACTION S/T	80.0	100.0	120.0												
STRAIN GXY	284.7	598.0	953.4	1367.0	1796.8	2301.0	2116.3	1861.4	1520.0	1148.5	515.9	307.1	493.8	811.0	1208.5
STRAIN GXY	1608.1	2003.8	2478.0												

ELEMENT NO 10SS MODULUS 1.0220

ACTION S/T	2.4	4.0	6.0	8.0	10.0	14.4	12.0	9.6	7.2	4.8	2.4	0.0	2.4	4.8	7.2
ACTION S/T	9.6	12.0	14.4	16.0	20.0	24.0	28.0	36.0							
STRAIN GXY	32.1	60.2	124.3	224.6	381.1	826.6	798.5	758.4	718.3	658.1	581.9	491.7	509.8	547.9	594.0
STRAIN GXY	662.2	736.4	828.6	949.1	1854.4	2829.9	4263.2	7326.5							

ELEMENT NO 11SS MODULUS 1.0544

ACTION S/T	2.0	4.0	6.0	8.0	10.0	12.0	10.0	8.0	6.0	4.0	2.0	0.0	2.4	4.0	6.4
ACTION S/T	8.0	10.0	12.0	14.4	18.4	22.4	26.4								
STRAIN GXY	32.1	60.2	140.4	307.1	558.0	935.4	929.3	907.3	883.2	849.1	805.0	742.8	756.8	774.9	815.0
STRAIN GXY	853.1	899.2	959.4	1605.8	3316.1	6178.1	9348.1								

ELEMENT NO 12SS MODULUS 1.0952

ACTION S/T	2.0	3.6	5.6	7.2	7.6	8.4	7.2	6.0	4.4	2.8	1.6	0.0	1.2	2.8	4.0
ACTION S/T	5.6	6.8	8.4	10.0	11.6										
STRAIN GXY	10.0	46.2	200.7	588.1	748.8	1073.9	1071.9	1065.8	1043.8	1021.7	995.6	951.4	953.5	965.5	989.6
STRAIN GXY	1021.7	1039.7	1106.0	2748.0	7092.2										

ELEMENT NO 13SS MODULUS 1.1283

ACTION S/T	20.0	40.0	60.0	80.0	100.0	120.0	100.0	80.0	60.0	40.0	20.0	0.0	20.0	40.0	60.0
ACTION S/T	80.0	100.0	120.0	0.0											
STRAIN GXY	215.0	528.5	722.4	1011.4	1374.6	1765.9	1573.2	1328.4	1017.4	688.2	298.9	42.1	244.8	531.7	838.8
STRAIN GXY	1163.9	1487.1	1856.5	58.2											

ELEMENT NO 14SS MODULUS 1.1715

ACTION S/T	2.4	4.8	7.2	9.6	12.0	16.8	14.0	11.2	8.4	5.6	2.8	0.0	2.8	5.6	8.8
ACTION S/T	11.6	14.4	16.8	20.0	24.0	29.6	36.0	44.0							
STRAIN GXY	30.1	74.2	150.4	262.7	411.1	894.7	874.7	842.6	810.5	766.4	706.3	624.1	642.1	682.2	726.4
STRAIN GXY	784.5	846.6	916.9	1392.5	2179.2	3489.9	5581.5	9200.5							

ELEMENT NO 15SS MODULUS 1.2129

ACTION S/T	2.4	4.8	7.2	8.8	9.6	11.2	9.6	7.2	5.6	4.0	1.6	0.0	2.4	4.0	5.6
ACTION S/T	7.2	9.6	11.2	16.0	20.0	24.0	28.0								
STRAIN GXY	18.0	70.2	260.9	501.8	670.4	1132.2	1132.2	1110.1	1102.0	1086.0	1049.9	1017.8	1031.8	1045.9	1074.0
STRAIN GXY	1102.1	1144.2	1178.4	2818.4	5137.1	8114.3	12350.2								

ELEMENT NO 16SS MODULUS 1.2576

ACTION S/T	1.6	3.2	5.6	6.4	7.2	8.0	6.4	5.6	4.8	3.2	1.6	0.0	1.6	3.2	4.8
ACTION S/T	6.4	7.2	8.0	9.6	11.2	12.8									
STRAIN GXY	18.0	46.1	260.8	427.4	640.2	957.4	953.3	949.3	943.3	891.2	867.1	813.0	823.0	849.1	879.1
STRAIN GXY	923.3	945.3	981.4	2258.1	4954.5	9422.8									

TABLE C3 CONTINUED

ACTION S/t (psi) AND STRAIN γ_{xy} (microstrain) VALUES AT EACH INCREMENT

ELEMENT NO 17SS MODULUS 1.3089

ACTION S/T	20.0	40.0	60.0	80.0	100.0	120.0	100.0	80.0	60.0	40.0	20.0	0.0	20.0	40.0	60.0
ACTION S/T	80.0	100.0	120.0	0.0											
STRAIN GXY	182.6	429.5	674.5	927.5	1206.7	1504.0	1343.4	1134.6	895.6	640.5	329.3	138.6	299.2	538.1	783.0
STRAIN GXY	1022.0	1299.1	1564.2	152.7											

ELEMENT NO 18SS MODULUS 1.3711

ACTION S/T	2.4	4.8	8.0	11.2	12.8	14.4	12.0	9.6	7.2	4.8	2.4	0.0	2.4	4.8	7.2
ACTION S/T	9.6	12.0	14.4	18.4	26.4	34.4	42.4								
STRAIN GXY	30.1	54.1	170.5	419.3	610.0	850.8	828.7	806.7	772.6	726.5	676.4	606.2	622.2	644.3	682.4
STRAIN GXY	720.5	774.7	834.9	1467.1	3305.7	5903.5	9707.6								

ELEMENT NO 19SS MODULUS 1.4248

ACTION S/T	2.0	4.4	6.4	8.8	10.4	12.0	10.0	8.0	6.0	4.0	2.0	0.0	2.0	4.0	6.4
ACTION S/T	8.0	10.0	12.0	16.0	20.0	24.0									
STRAIN GXY	28.1	74.2	156.5	455.5	754.5	1123.8	1121.8	1093.7	1069.7	1033.6	975.4	895.2	907.3	915.3	953.4
STRAIN GXY	881.2	1037.6	1119.9	2609.3	4686.9	8259.1									

ELEMENT NO 20SS MODULUS 1.4691

ACTION S/T	1.6	3.2	4.8	6.4	6.8	7.6	6.0	4.8	3.6	2.4	1.2	0.0	1.2	2.4	4.0
ACTION S/T	4.8	6.0	7.6	9.2	11.2	13.6									
STRAIN GXY	28.1	76.3	192.7	483.7	690.5	947.4	945.4	927.4	909.3	889.2	857.1	831.0	835.1	847.1	863.2
STRAIN GXY	885.2	907.3	949.5	1738.4	4067.0	9898.7									

ELEMENT NO 21SS MODULUS 1.5342

ACTION S/T	20.0	40.0	60.0	80.0	100.0	120.0	100.0	80.0	60.0	40.0	20.0	0.0	20.0	40.0	60.0
ACTION S/T	80.0	100.0	120.0	0.0											
STRAIN GXY	64.2	315.1	570.0	844.9	1151.9	1464.7	1334.3	1043.3	794.4	521.6	208.6	-14.0	176.6	415.3	684.3
STRAIN GXY	947.1	1212.0	1492.7	-3.9											

ELEMENT NO 22SS MODULUS 1.6048

ACTION S/T	2.4	4.8	6.8	9.6	12.0	14.4	12.0	9.6	7.2	4.8	2.4	0.0	2.4	4.8	7.2
ACTION S/T	9.6	12.0	14.4	18.4	22.4	30.4	38.4								
STRAIN GXY	30.1	72.2	142.4	369.2	634.1	953.2	939.2	901.1	854.9	814.8	750.7	670.5	688.5	718.6	758.7
STRAIN GXY	810.9	869.1	945.3	1816.5	2671.7	5024.5	8280.6								

ELEMENT NO 23SS MODULUS 1.6808

ACTION S/T	2.0	4.0	5.6	6.4	7.2	8.0	6.8	5.6	4.4	3.2	1.6	0.0	1.2	2.4	4.0
ACTION S/T	5.6	6.8	8.0	9.6	11.2	13.6	16.8	20.0							
STRAIN GXY	32.1	120.5	323.4	534.2	720.9	915.6	915.6	905.6	883.5	865.4	811.2	702.7	718.8	728.8	750.9
STRAIN GXY	793.1	845.4	939.7	1612.3	2258.8	3294.8	5240.1	7464.6							

ELEMENT NO 24SS MODULUS 1.7979

ACTION S/T	1.2	2.4	4.0	5.6	7.6	9.2	7.6	6.0	4.4	2.8	1.2	0.0	1.6	3.2	4.8
ACTION S/T	6.4	8.0	9.2	11.2	14.4	16.0									
STRAIN GXY	6.0	20.1	62.2	146.5	522.0	1078.1	1070.0	1050.0	1031.9	1007.8	971.7	943.6	959.7	971.7	997.8
STRAIN GXY	1031.9	1052.0	1098.1	2379.0	6217.5	9959.5									

TABLE C4 DATA FROM BENDING AND TORSION TESTS ON MODEL ELEMENTS

VALUES OF ACTION M_1 (lb-in/in) AND CURVATURE k_x ($\times 10^{-4} in^{-1}$) AT EACH INCREMENT

ELEMENT NO 1 MODULUS 0.5450

ACTION M	0.0	7.2	14.4	21.6	28.8	36.0	43.2	36.0	28.8	21.6	14.4	7.3	0.0	7.2	14.4	21.7	28.9	36.1	43.3	0.0
K*10PWR-4	0.0	13.19	25.35	37.50	49.31	60.76	72.57	63.89	53.13	41.32	28.47	15.28	1.04	13.89	26.04	37.85	49.65	61.81	73.26	1.74

ELEMENT NO 2A MODULUS 0.7458

ACTION M	0.0	3.8	7.5	11.3	15.1	18.8	22.6	18.8	15.1	11.3	7.6	3.8	0.0	3.8	7.5	11.3	15.1	18.8	22.6	0.0
K*10PWR-4	0.0	5.56	11.81	17.01	23.26	29.86	37.15	33.33	28.82	22.92	18.06	12.15	4.86	9.72	15.63	20.49	26.04	31.94	37.50	5.21

ELEMENT NO 2B MODULUS 0.8483

ACTION M	0.0	2.7	5.4	8.1	10.7	13.4	16.1	13.4	10.7	8.1	5.4	2.7	0.0	2.7	5.4	8.1	10.8	13.5	16.2	0.0
K*10PWR-4	0.0	5.56	12.50	19.10	27.43	38.89	49.31	47.22	43.40	38.19	33.33	26.74	17.01	20.83	25.69	31.25	37.50	44.10	51.39	18.40

ELEMENT NO 3 MODULUS 0.8825

ACTION M	0.0	3.3	5.4	7.5	9.0	10.5	12.0	10.1	8.1	6.0	4.0	2.0	0.0	2.1	4.0	6.0	8.1	10.1	12.1	0.0
K*10PWR-4	0.0	10.07	20.49	30.21	41.67	52.78	63.89	62.15	58.68	51.39	40.63	26.74	10.42	17.01	26.74	37.15	47.92	56.25	65.63	10.76

ELEMENT NO 4A MODULUS 0.9517

ACTION M	0.0	11.3	22.7	34.0	45.4	56.7	68.1	56.7	45.4	34.1	22.7	11.4	0.0	11.3	22.7	34.0	45.4	56.7	68.1	0.0
K*10PWR-4	0.0	10.42	21.18	31.60	41.32	51.39	61.46	53.82	43.75	33.33	22.92	11.81	0.69	11.11	21.88	31.94	41.67	52.08	61.81	1.04

ELEMENT NO 4B MODULUS 0.9917

ACTION M	0.0	6.7	11.9	16.6	20.7	24.4	27.7	23.1	18.5	13.9	9.2	4.6	0.0	4.6	9.3	13.9	18.5	23.1	27.8	0.0
K*10PWR-4	0.0	8.33	15.28	22.92	30.56	39.58	47.92	44.10	39.58	34.03	28.82	21.88	13.19	18.06	22.92	28.47	34.03	40.63	47.92	13.54

ELEMENT NO 5 MODULUS 1.0125

ACTION M	0.0	3.0	5.9	8.9	11.8	14.8	17.8	14.8	11.9	8.9	6.0	3.0	0.0	3.0	5.9	8.9	11.8	14.8	17.7	0.0
K*10PWR-4	0.0	5.90	13.19	20.83	31.60	44.79	61.46	58.68	54.86	49.31	41.67	32.64	20.14	23.96	30.56	39.24	46.88	54.86	64.24	21.53

ELEMENT NO 6A MODULUS 1.0550

ACTION M	0.0	4.2	7.1	9.4	11.3	13.3	15.3	12.7	10.2	7.6	5.1	2.6	0.0	2.6	5.1	7.7	10.2	12.8	15.3	0.0
K*10PWR-4	0.0	10.07	18.40	29.13	37.85	48.61	59.38	57.29	54.51	48.61	40.28	29.51	16.67	19.79	25.69	33.68	42.71	51.04	59.38	17.01

ELEMENT NO 6B MODULUS 1.0967

ACTION M	0.0	14.3	27.5	41.7	56.2	71.2	85.6	71.4	57.1	42.8	28.5	14.3	0.0	14.3	28.5	42.8	57.1	71.4	85.6	0.0
K*10PWR-4	0.0	11.11	21.53	33.68	44.44	55.56	66.67	58.68	48.26	36.81	25.00	13.54	0.69	11.81	23.96	34.72	45.14	55.56	66.32	0.69

ELEMENT NO 7 MODULUS 1·1175

ACTION M	0.0	9.4	16.8	22.9	28.2	32.6	37.0	30.8	24.7	18.5	12.4	6.2	0.0	6.1	12.3	18.5	24.6	30.8	37.0	0.0
K*10PWR-4	0.0	9.03	16.32	22.92	29.51	36.46	43.75	39.93	35.42	29.86	23.96	18.40	10.07	15.63	20.83	26.39	32.29	37.85	44.44	10.42

ELEMENT NO 8A MODULUS 1.1442

ACTION M	0.0	5.9	9.7	13.0	16.0	18.6	21.7	18.1	14.5	10.9	7.3	3.7	0.0	3.7	7.3	10.9	14.5	18.1	21.7	0.0
K*10PWR-4	0.0	7.99	16.67	25.00	34.03	43.06	53.13	51.39	47.92	43.40	38.19	29.86	18.75	22.22	27.08	32.29	39.24	47.22	55.90	19.10

ELEMENT NO 8B MODULUS 1.1692

ACTION M	0.0	4.2	7.1	9.4	11.3	13.3	15.2	12.6	10.1	7.6	5.1	2.5	0.0	2.5	5.1	7.6	10.1	12.6	15.2	0.0
K*10PWR-4	0.0	8.33	18.40	28.82	39.58	50.35	61.11	59.72	56.60	50.69	42.36	30.56	16.67	19.79	25.35	33.33	43.40	53.47	63.19	17.36

TABLE C4 CONTINUED

VALUES OF ACTION M_1 (lb-in/in) AND CURVATURE k_x ($\times 10^{-4}$ in^{-1}) AT EACH INCREMENT

ELEMENT NO 9 MODULUS 1.1992

ACTION M	0.0	10.3	26.2	43.1	59.9	77.1	94.2	78.5	62.8	47.1	31.4	15.7	0.0	15.7	31.4	47.1	62.8	78.5	94.3	0.0
K*10PWR-4	0.0	6.94	18.40	30.21	41.32	52.43	63.89	55.90	45.83	35.07	23.61	12.15	0.69	11.46	23.26	33.68	43.75	54.17	64.24	0.69

ELEMENT NO 10A MODULUS 1.2475

ACTION M	0.0	4.9	9.9	14.8	19.8	24.7	29.7	24.7	19.8	14.8	9.9	4.9	0.0	5.0	9.9	14.9	19.8	24.8	29.7	0.0
K*10PWR-4	0.0	4.51	9.38	14.24	20.49	26.74	34.38	31.25	27.43	23.61	18.40	13.54	7.29	11.11	15.63	20.49	24.65	29.51	35.07	7.64

ELEMENT NO 10B MODULUS 1.2950

ACTION M	0.0	6.7	11.1	14.8	18.2	21.0	23.6	19.7	15.7	11.8	7.9	4.0	0.0	4.0	7.9	11.8	15.7	19.7	23.6	0.0
K*10PWR-4	0.0	8.33	17.71	27.43	36.81	47.22	57.64	55.56	52.78	48.61	41.67	31.60	18.75	21.88	26.39	33.33	42.01	50.69	59.38	18.75

ELEMENT NO 11 MODULUS 1.3308

ACTION M	0.0	3.8	6.7	9.2	11.7	14.0	16.3	13.6	10.9	8.2	5.4	2.7	0.0	2.7	5.4	8.2	10.9	13.6	16.4	0.0
K*10PWR-4	0.0	8.68	19.10	30.56	42.36	53.82	64.58	62.85	59.03	52.08	42.01	28.82	15.28	19.79	27.43	37.50	46.88	56.25	65.63	16.32

ELEMENT NO 12A MODULUS 1.3767

ACTION M	0.0	18.3	36.9	56.0	74.3	93.5	111.7	91.3	70.8	50.5	30.0	9.6	0.0	13.2	37.3	55.9	74.5	93.1	111.8	0.0
K*10PWR-4	0.0	12.85	24.65	36.81	47.92	60.07	71.88	61.81	48.26	35.07	21.53	7.64	0.35	9.72	25.69	37.50	48.61	61.11	72.22	1.74

ELEMENT NO 12B MODULUS 1.4192

ACTION M	0.0	10.4	17.7	23.4	27.8	32.1	35.7	29.7	23.8	17.8	11.9	5.9	0.0	5.9	11.9	17.9	23.8	29.8	35.7	0.0
K*10PWR-4	0.0	8.33	15.97	23.96	31.60	39.93	48.96	45.49	41.32	35.76	29.51	22.22	13.89	17.71	22.57	28.82	35.07	42.01	50.00	14.58

ELEMENT NO 13 MODULUS 1.4642

ACTION M	0.0	6.3	10.7	14.3	18.0	21.2	23.9	20.0	16.1	12.2	8.3	4.4	0.0	4.4	8.3	12.2	16.1	20.0	23.9	0.0
K*10PWR-4	0.0	4.17	17.36	27.43	37.50	48.26	58.68	56.60	54.51	48.96	42.01	31.94	17.36	20.83	27.08	35.07	42.36	51.39	59.03	17.36

ELEMENT NO 14A MODULUS 1.5450

ACTION M	0.0	3.6	6.3	8.7	10.8	13.1	14.9	12.5	10.0	7.5	5.0	2.5	0.0	2.5	5.0	7.5	10.0	12.5	14.9	0.0
K*10PWR-4	0.0	7.99	18.75	29.17	40.28	51.04	63.19	61.11	56.60	47.92	37.50	25.35	12.50	16.32	25.35	35.76	45.83	54.17	63.54	7.99

ELEMENT NO 14B MODULUS 1.5883

ACTION M	0.0	18.2	36.3	54.5	72.6	90.8	108.9	90.7	72.6	54.4	36.2	18.0	0.0	18.2	36.4	54.5	72.7	90.9	109.1	0.0
K*10PWR-4	0.0	10.42	21.18	30.90	39.93	50.35	60.07	52.43	42.71	32.64	22.57	11.46	0.69	11.11	21.53	31.60	40.97	50.69	60.42	0.69

ELEMENT NO 15 MODULUS 1.6375

ACTION M	0.0	9.9	17.7	21.2	28.9	33.5	37.5	31.2	25.0	18.7	12.5	6.2	0.0	6.3	12.5	18.8	25.1	31.3	37.6	0.0
K*10PWR-4	0.0	8.68	16.32	29.49	33.33	42.71	52.08	48.61	44.10	38.89	32.99	25.69	15.97	19.79	25.35	30.56	37.50	44.44	52.43	16.32

ELEMENT NO 16A MODULUS 1.7025

ACTION M	0.0	6.1	10.6	14.6	18.5	21.9	25.3	21.1	16.9	12.6	8.4	4.2	0.0	4.2	8.5	12.7	16.9	21.1	25.4	0.0
K*10PWR-4	0.0	8.68	18.75	28.47	38.89	49.65	60.42	59.03	55.56	50.35	43.40	32.64	18.40	21.88	28.82	36.46	44.44	53.47	61.81	18.40

ELEMENT NO 16B MODULUS 1.7483

ACTION M	0.0	4.1	8.3	12.4	16.5	20.7	24.8	20.7	16.5	12.4	8.2	4.1	0.0	4.1	8.3	12.4	16.6	20.7	24.9	0.0
K*10PWR-4	0.0	2.78	7.29	13.19	20.14	29.17	37.50	36.46	33.68	30.56	26.39	20.14	12.85	15.63	19.10	22.92	27.08	33.68	39.58	13.19

TABLE C4 CONTINUED

ACTION M_2 (lb-in/in) AND CURVATURE k_y ($\times 10^{-4} in^{-1}$) VALUES AT EACH INCREMENT

ELEMENT NO	MODULUS																				
1A	0.5643	ACTION M	0.0	1.0	1.8	2.5	3.3	4.0	4.8	4.0	3.2	2.4	1.6	0.8	0.0	0.8	1.6	2.4	3.3	4.1	4.8	0.0
		K*10PWR-4	0.0	12.15	22.92	34.03	45.14	57.29	68.75	63.54	53.82	39.93	29.51	16.67	5.56	15.63	26.04	37.85	49.65	60.76	71.18	6.25
1B	0.7300	ACTION M	0.0	0.5	1.1	1.7	2.3	2.8	3.5	2.9	2.3	1.7	1.1	0.5	0.0	0.6	1.2	1.8	2.4	3.0	3.6	0.0
		K*10PWR-4	0.0	11.46	24.31	37.50	50.00	62.15	73.96	66.67	57.29	45.49	31.60	15.28	4.17	15.97	28.82	42.36	53.82	65.63	74.31	4.51
2	0.8583	ACTION M	0.0	0.6	1.3	1.9	2.5	3.2	3.9	3.2	2.6	1.9	1.3	0.6	0.0	0.7	1.3	2.0	2.6	3.3	3.9	0.0
		K*10PWR-4	0.0	15.63	28.82	42.01	53.82	66.67	78.47	70.49	59.38	49.65	35.42	22.22	7.99	21.53	31.94	44.79	54.86	67.01	77.43	8.68
3A	0.8817	ACTION M	0.0	0.7	1.4	2.0	2.7	3.3	3.9	3.2	2.6	1.9	1.3	0.6	0.0	0.7	1.3	2.0	2.6	3.3	3.9	0.0
		K*10PWR-4	0.0	11.81	23.61	34.38	45.83	57.64	68.75	61.81	52.08	42.01	30.56	21.53	8.33	18.06	29.17	39.93	49.31	59.38	69.44	8.33
3B	0.9333	ACTION M	0.0	1.2	2.2	3.2	4.4	5.3	6.2	5.2	4.2	3.1	2.1	1.1	0.0	1.1	2.1	3.1	4.2	5.2	6.2	0.0
		K*10PWR-4	0.0	13.54	26.04	37.50	51.39	62.50	75.00	65.63	54.86	41.32	29.17	16.32	3.82	15.63	26.74	39.24	51.04	63.54	75.00	5.21
4	1.0000	ACTION M	0.0	0.8	1.6	2.5	3.2	4.1	4.8	4.0	3.2	2.4	1.6	0.8	0.0	0.8	1.6	2.4	3.2	4.0	4.8	0.0
		K*10PWR-4	0.0	12.15	25.00	38.54	51.39	64.93	77.08	66.32	54.86	41.32	27.78	15.97	3.47	13.89	25.35	39.24	51.04	62.85	75.69	3.82
5A	1.0217	ACTION M	0.0	0.8	1.6	2.4	3.2	4.1	4.9	4.1	3.3	2.4	1.6	0.8	0.0	0.8	1.6	2.4	3.3	4.1	4.9	0.0
		K*10PWR-4	0.0	11.11	23.96	35.07	46.53	59.03	70.49	63.19	53.82	40.63	30.56	17.36	6.60	11.46	27.43	37.85	49.65	61.46	72.57	6.60
5B	1.0333	ACTION M	0.0	0.7	1.5	2.1	3.0	3.8	4.6	3.8	3.1	2.3	1.6	0.8	0.0	0.8	1.6	2.3	3.1	3.8	4.6	0.0
		K*10PWR-4	0.0	11.81	24.31	36.46	47.92	60.42	71.18	64.24	55.56	46.18	35.42	21.53	6.60	18.75	30.21	39.93	50.35	60.07	70.14	7.99
6	1.0917	ACTION M	0.0	1.2	2.2	3.3	4.5	5.8	7.0	5.8	4.6	3.5	2.3	1.1	0.0	1.1	2.3	3.5	4.6	5.8	7.0	0.0
		K*10PWR-4	0.0	12.15	23.61	35.07	47.92	59.72	71.88	64.58	54.17	41.32	30.21	16.67	3.47	14.58	27.43	39.24	53.69	61.81	71.88	3.82
7A	1.1167	ACTION M	0.0	1.1	2.2	3.1	4.1	5.1	6.2	5.2	4.1	3.1	2.1	1.1	0.0	1.1	2.1	3.1	4.1	5.2	6.2	0.0
		K*10PWR-4	0.0	10.76	22.92	34.72	42.71	58.33	70.14	62.15	50.00	39.93	27.43	15.63	3.82	14.24	25.30	36.11	47.22	58.68	69.44	4.17
7B	1.1067	ACTION M	0.0	0.9	1.7	2.5	3.3	4.3	5.2	4.3	3.4	2.6	1.7	0.9	0.0	0.9	1.7	2.6	3.4	4.3	5.2	0.0
		K*10PWR-4	0.0	11.46	22.22	34.03	45.14	56.60	68.75	59.72	51.04	39.24	28.13	16.32	3.13	13.89	24.31	35.42	46.53	56.60	67.01	3.82
8	1.1717	ACTION M	0.0	0.6	1.3	2.1	2.9	3.5	4.4	3.7	2.9	2.2	1.5	0.6	0.0	0.6	1.5	2.2	2.9	3.7	4.4	0.0
		K*10PWR-4	0.0	10.42	21.53	34.38	45.83	57.64	69.44	61.11	49.65	38.54	27.08	13.89	3.47	10.76	23.96	35.76	46.18	58.33	67.01	3.82

TABLE C4 CONTINUED

VALUES OF ACTION M_2 (lb-in/in) AND CURVATURE k_y ($\times 10^{-4}$ in^{-1}) AT EACH INCREMENT

ELEMENT NO 9A	MODULUS 1.2050																				
ACTION M	0.0	1.2	2.5	3.8	5.1	6.4	7.7	6.4	5.1	3.8	2.5	1.2	0.0	1.2	2.5	3.8	5.1	6.4	7.7	0.0	
K*10PWR-4	0.0	11.11	24.31	37.50	49.31	62.15	73.61	66.32	55.90	43.40	30.56	17.01	3.13	14.58	27.78	39.24	51.39	62.50	73.96	3.47	
ELEMENT NO 9B	MODULUS 1.2300																				
ACTION M	0.0	1.0	1.8	2.7	3.8	4.7	5.5	4.6	3.7	2.8	1.9	1.0	0.0	1.0	1.9	2.8	3.7	4.6	5.5	0.0	
K*10PWR-4	0.0	13.89	25.35	37.85	51.39	63.54	76.39	65.63	54.86	41.67	29.51	17.36	4.86	16.32	27.78	38.89	51.39	62.50	73.61	5.21	
ELEMENT NO 10	MODULUS 1.2650																				
ACTION M	0.0	1.0	2.0	3.2	4.2	5.4	6.4	5.4	4.3	3.2	2.1	1.1	0.0	1.1	2.1	3.2	4.3	5.4	6.4	0.0	
K*10PWR-4	0.0	12.50	23.96	36.81	47.92	60.76	72.57	63.54	52.08	41.32	30.21	17.71	5.90	16.67	28.13	39.58	50.35	61.11	72.57	6.25	
ELEMENT NO 11A	MODULUS 1.3417																				
ACTION M	0.0	0.9	1.8	2.8	3.9	5.1	6.3	5.2	4.2	3.1	2.1	1.0	0.0	1.0	2.1	3.1	4.2	5.2	6.3	0.0	
K*10PWR-4	0.0	10.76	22.92	34.72	46.88	58.33	69.44	62.50	52.78	41.67	29.86	16.67	3.47	14.93	26.74	37.85	48.61	58.33	68.40	3.82	
ELEMENT NO 11B	MODULUS 1.3583																				
ACTION M	0.0	1.3	2.5	3.8	5.0	6.3	7.5	6.3	5.0	3.7	2.5	1.2	0.0	1.2	2.5	3.7	5.0	6.3	7.5	0.0	
K*10PWR-4	0.0	12.15	25.35	38.19	51.39	63.89	76.74	66.67	55.56	42.01	28.82	15.97	3.82	14.24	27.08	39.24	52.08	63.54	76.04	4.17	
ELEMENT NO 12	MODULUS 1.4167																				
ACTION M	0.0	1.3	2.5	3.8	4.9	6.3	7.4	6.2	4.9	3.7	2.5	1.2	0.0	1.2	2.5	3.7	4.9	6.2	7.4	0.0	
K*10PWR-4	0.0	11.81	23.96	35.07	46.88	58.68	70.83	61.46	50.35	38.19	25.35	14.24	3.13	13.89	24.31	35.07	46.88	59.03	70.83	3.82	
ELEMENT NO 13A	MODULUS 1.4917																				
ACTION M	0.0	1.2	2.4	3.6	4.9	6.2	7.5	6.2	5.0	3.8	2.5	1.3	0.0	1.3	2.5	3.8	5.0	6.2	7.5	0.0	
K*10PWR-4	0.0	10.42	21.18	33.33	44.10	54.86	66.32	57.99	48.61	38.19	26.74	14.93	2.43	13.19	24.31	34.72	44.44	54.51	64.93	2.43	
ELEMENT NO 13B	MODULUS 1.5233																				
ACTION M	0.0	1.1	2.1	3.3	4.5	5.7	6.9	5.9	4.6	3.4	2.3	1.1	0.0	1.1	2.3	3.4	4.6	5.8	6.9	0.0	
K*10PWR-4	0.0	10.76	21.88	33.68	45.49	56.94	68.40	60.76	51.04	39.93	28.82	16.32	3.47	13.54	25.00	35.76	46.53	56.60	67.71	3.47	
ELEMENT NO 14	MODULUS 1.6033																				
ACTION M	0.0	1.5	2.8	4.4	5.7	7.3	8.7	7.3	5.8	4.4	2.9	1.5	0.0	1.5	2.9	4.4	5.8	7.3	8.7	0.0	
K*10PWR-4	0.0	12.15	25.00	36.81	49.31	61.46	74.31	65.97	53.82	42.01	29.51	15.97	2.43	14.58	28.13	39.58	50.69	63.54	76.04	2.78	
ELEMENT NO 15A	MODULUS 1.6533																				
ACTION M	0.0	1.4	2.6	3.8	4.9	6.2	7.4	6.0	4.9	3.7	2.5	1.2	0.0	1.2	2.5	3.7	4.9	6.2	7.4	0.0	
K*10PWR-4	0.0	13.89	26.04	38.99	50.35	63.54	75.35	64.93	54.51	43.06	30.21	17.36	3.47	15.97	28.47	40.28	51.39	63.54	75.00	3.82	
ELEMENT NO 15B	MODULUS 1.6733																				
ACTION M	0.0	1.2	2.5	3.9	5.3	6.7	8.2	6.9	5.4	4.1	2.7	1.4	0.0	1.4	2.7	4.1	5.5	6.8	8.2	0.0	
K*10PWR-4	0.0	11.81	24.31	36.11	48.61	60.07	73.26	65.63	54.17	42.36	29.17	16.67	3.47	14.93	27.43	38.54	49.31	59.38	70.49	3.82	
ELEMENT NO 16	MODULUS 1.7700																				
ACTION M	0.0	1.3	2.5	3.7	5.0	6.3	7.5	6.3	5.0	3.7	2.5	1.2	0.0	1.2	2.5	3.7	5.0	6.3	7.5	0.0	
K*10PWR-4	0.0	11.46	23.96	36.11	49.26	59.38	72.22	64.24	53.13	41.32	28.13	16.32	3.82	14.58	25.69	37.50	49.26	59.38	70.49	3.82	

TABLE C4 DATA FROM MODEL FLEXURE TESTS - CONTINUED - TORSION

ELEMENT LABEL 1 AVERAGE MODULUS 0.6580

H lb-in/in	0.997	1.999	2.997	3.999	4.996	5.998	4.997	4.000	2.999	2.002	1.001	0.0	0.997	1.999	2.995	3.997	4.994	5.996
TWIST deg	6.80	14.97	23.36	32.20	40.70	50.57	46.26	40.48	33.56	25.17	16.33	6.92	12.02	19.16	27.32	35.94	44.10	52.95

ELEMENT LABEL 2 AVERAGE MODULUS 0.8118

H lb-in/in	0.349	0.699	1.052	1.402	1.751	2.100	1.752	1.403	1.055	0.702	0.353	0.0	0.350	0.699	1.053	1.403	1.752	2.102
TWIST deg	2.49	9.07	18.03	26.64	35.15	44.44	42.86	40.70	37.87	34.24	29.37	22.56	24.26	26.42	29.59	33.67	38.89	45.12

ELEMENT LABEL 3 AVERAGE MODULUS 0.9067

H lb-in/in	0.326	0.648	0.974	1.301	1.622	1.949	1.622	1.301	0.974	0.648	0.326	0.0	0.327	0.649	0.976	1.303	1.626	1.953
TWIST deg	8.84	19.84	30.50	40.59	51.13	61.79	59.07	54.54	47.73	39.23	29.25	18.14	21.77	27.89	35.49	44.44	53.74	62.59

ELEMENT LABEL 4 AVERAGE MODULUS 0.9765

H lb-in/in	0.299	0.598	0.911	1.201	1.500	1.799	1.500	1.201	0.911	0.598	0.299	0.0	0.299	0.598	0.911	1.201	1.500	1.799
TWIST deg	5.90	15.08	26.30	35.94	45.80	54.88	53.29	50.00	46.37	39.80	31.18	22.00	24.49	27.66	33.79	39.91	48.19	56.01

ELEMENT LABEL 5 AVERAGE MODULUS 1.0276

H lb-in/in	0.997	1.999	2.997	3.999	4.996	5.998	4.997	4.000	2.999	2.002	1.001	0.0	0.997	1.999	2.995	3.997	4.994	5.996
TWIST deg	5.78	12.81	20.75	28.57	37.07	45.46	41.27	36.17	29.37	22.11	14.17	6.12	11.00	16.89	24.04	31.75	39.46	47.39

ELEMENT LABEL 6 AVERAGE MODULUS 1.0782

H lb-in/in	0.349	0.699	1.052	1.411	1.751	2.100	1.752	1.412	1.055	0.702	0.353	0.0	0.349	0.698	1.051	1.409	1.749	2.098
TWIST deg	3.06	7.82	13.95	20.98	29.14	37.98	36.28	34.13	31.41	28.12	23.92	19.39	21.43	23.81	26.87	30.27	34.01	38.21

ELEMENT LABEL 7 AVERAGE MODULUS 1.1234

H lb-in/in	0.327	0.649	0.975	1.302	1.624	1.951	1.625	1.304	0.978	0.652	0.330	0.0	0.327	0.649	0.976	1.303	1.626	1.953
TWIST deg	3.29	10.66	20.19	29.59	39.12	50.00	48.41	46.26	43.31	39.68	34.69	26.87	28.46	30.84	33.90	38.21	44.56	50.00

ELEMENT LABEL 8 AVERAGE MODULUS 1.1694

H lb-in/in	0.299	0.598	0.911	1.201	1.500	1.799	1.500	1.201	0.911	0.598	0.299	0.0	0.300	0.599	0.913	1.204	1.503	1.803
TWIST deg	5.78	16.78	28.34	38.21	49.32	58.84	57.03	54.54	50.91	44.10	35.49	24.60	26.87	29.82	35.37	42.52	51.25	59.86

TABLE C4 CONTINUED

ELEMENT LABEL 9 AVERAGE MODULUS 1.2145

H lb-in/in	0.997	1.998	2.994	3.995	4.992	5.993	4.991	3.994	2.992	1.995	0.993	0.0	0.998	2.000	2.997	4.000	4.997	5.999
TWIST k_{xy}	6.24	14.17	22.79	31.63	40.82	51.13	47.17	41.72	34.92	26.87	18.03	8.16	13.27	20.07	27.89	36.28	45.01	53.40

ELEMENT LABEL 10 AVERAGE MODULUS 1.2776

H lb-in/in	0.349	0.698	1.051	1.409	1.749	2.098	1.749	1.409	1.051	0.698	0.349	0.0	0.349	0.698	1.051	1.409	1.749	2.098
TWIST k_{xy}	3.17	8.62	16.10	24.04	31.52	40.48	38.89	37.19	34.92	31.86	27.32	21.09	22.79	24.60	27.44	30.73	35.03	40.59

ELEMENT LABEL 11 AVERAGE MODULUS 1.3335

H lb-in/in	0.327	0.650	0.977	1.304	1.626	1.953	1.628	1.307	0.981	0.656	0.335	0.0	0.326	0.648	0.974	1.301	1.622	1.949
TWIST k_{xy}	3.17	10.20	18.82	27.21	36.17	45.92	44.10	41.95	39.23	35.60	30.27	23.02	24.72	26.98	30.05	34.01	39.12	45.46

ELEMENT LABEL 12 AVERAGE MODULUS 1.4049

H lb-in/in	0.300	0.600	0.914	1.205	1.506	1.806	1.508	1.210	0.912	0.610	0.312	0.0	0.299	0.598	0.902	1.201	1.500	1.799
TWIST k_{xy}	3.17	11.68	23.02	31.63	41.84	52.27	50.23	47.51	42.97	35.83	26.87	16.10	18.59	22.34	28.34	36.05	44.67	53.29

ELEMENT LABEL 13 AVERAGE MODULUS 1.4886

H lb-in/in	0.997	1.999	2.997	3.999	4.996	5.998	4.997	4.000	2.999	2.002	1.001	0.0	1.002	2.004	3.002	4.004	5.002	6.004
TWIST k_{xy}	6.24	13.49	21.43	29.48	37.41	46.03	40.59	34.81	28.46	20.52	12.02	3.40	9.07	16.21	23.81	31.97	39.57	47.62

ELEMENT LABEL 14 AVERAGE MODULUS 1.5768

H lb-in/in	0.349	0.698	1.051	1.409	1.749	2.098	1.749	1.409	1.051	0.698	0.349	0.0	0.350	0.699	1.053	1.412	1.752	2.102
TWIST k_{xy}	2.49	7.26	13.61	22.68	30.61	38.66	36.73	34.69	33.33	28.91	24.26	19.39	21.09	23.36	26.19	29.93	34.01	39.34

ELEMENT LABEL 15 AVERAGE MODULUS 1.6531

H lb-in/in	0.327	0.649	0.975	1.302	1.624	1.951	1.625	1.304	0.978	0.652	0.330	0.0	0.327	0.649	0.976	1.303	1.626	1.953
TWIST k_{xy}	2.83	9.75	18.82	27.73	37.07	46.60	44.78	42.74	39.80	36.17	30.61	22.79	24.72	26.87	29.71	34.01	39.80	46.83

ELEMENT LABEL 16 AVERAGE MODULUS 1.7455

H lb-in/in	0.299	0.598	0.911	1.201	1.500	1.799	1.500	1.201	0.911	0.598	0.299	0.0	0.299	0.598	0.911	1.201	1.500	1.799
TWIST k_{xy}	5.90	14.63	24.38	34.01	42.86	51.25	49.77	47.51	44.44	39.12	32.20	23.81	25.51	28.12	31.97	37.30	44.33	51.81

TABLE D1 DATA FROM TESTS ON MODEL SHELLS - SHELL 1, NAIL-GLUED

APPROX. PRESS. LB/SQFT	WATER MANOMETER FT HEAD	LOAD CELL LOADINGS LBS SW	SE	NE	NW	DIAL GAUGES READ TO NEAREST .001 INCH 18	4	1	2	3	4	5	6
0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.	0.080	35.59	47.72	43.21	42.08	0.0145	0.0105	0.0050	0.0080	0.0100	0.0105	0.0090	0.0085
10.	0.162	81.19	88.78	88.63	91.91	0.0295	0.0225	0.0090	0.0155	0.0205	0.0225	0.0200	0.0165
15.	0.240	125.67	134.28	134.05	137.31	0.0465	0.0360	0.0145	0.0255	0.0335	0.0360	0.0320	0.0265
20.	0.320	171.27	179.78	179.47	186.03	0.0635	0.0490	0.0200	0.0345	0.0450	0.0490	0.0445	0.0405
15.	0.248	126.79	137.61	135.16	141.74	0.0490	0.0395	0.0160	0.0280	0.0360	0.0395	0.0355	0.0300
10.	0.172	84.52	93.22	90.84	94.12	0.0330	0.0280	0.0120	0.0205	0.0260	0.0280	0.0255	0.0215
5.	0.085	34.48	46.61	40.99	40.97	0.0165	0.0160	0.0070	0.0120	0.0150	0.0160	0.0145	0.0125
0.	0.008	-8.90	3.33	1.11	3.32	0.0010	0.0040	0.0020	0.0030	0.0035	0.0040	0.0030	0.0040
0.	0.005	-10.01	2.22	0.0	2.21	-0.0015	0.0050	0.0020	0.0040	0.0050	0.0050	0.0035	0.0050
5.	0.084	38.93	51.05	49.85	55.37	0.0170	0.0205	0.0085	0.0145	0.0185	0.0205	0.0180	0.0155
10.	0.164	80.07	86.56	87.52	90.80	0.0290	0.0295	0.0115	0.0210	0.0265	0.0295	0.0270	0.0225
15.	0.242	123.45	132.06	129.62	133.99	0.0440	0.0410	0.0165	0.0285	0.0375	0.0410	0.0375	0.0305
20.	0.326	169.05	175.34	170.61	177.18	0.0605	0.0530	0.0215	0.0375	0.0485	0.0520	0.0490	0.0395
30.	0.489	258.02	267.45	264.78	273.52	0.0965	0.0790	0.0305	0.0550	0.0725	0.0790	0.0720	0.0575
40.	0.649	345.88	352.90	353.40	364.32	0.1345	0.1035	0.0415	0.0730	0.0965	0.1035	0.0955	0.0760
50.	0.813	437.07	445.01	439.82	455.12	0.1745	0.1295	0.0515	0.0915	0.1200	0.1295	0.1190	0.0945
60.	0.981	526.05	526.02	520.69	540.39	0.2170	0.1555	0.0620	0.1100	0.1445	0.1555	0.1430	0.1135
80.	1.302	700.65	710.24	704.59	726.42	0.3100	0.2035	0.0825	0.1460	0.1900	0.2035	0.1885	0.1500
100.	1.626	879.71	887.80	881.85	912.46	0.4160	0.2525	0.1075	0.1810	0.2370	0.2515	0.2340	0.1860
120.	1.952	1058.77	1070.91	1062.43	1098.49	0.5410	0.3020	0.1240	0.2185	0.2860	0.3025	0.2810	0.2230
140.	0.0	1236.71	0.0	0.0	0.0	0.6840	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60.	0.970	524.93	534.90	531.77	547.03	0.3240	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.	0.0	-8.90	2.22	0.0	4.43	0.0600	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.	0.0	-11.12	0.0	1.11	1.11	0.0355	-0.0635	-0.1010	-0.0520	-0.2540	-0.0615	0.1830	-0.0045
40.	0.650	348.10	359.56	356.73	363.21	0.1715	0.0465	-0.0590	0.0225	-0.1555	0.0440	0.2815	0.0730
80.	1.299	703.99	714.68	709.02	721.99	0.3445	0.1515	-0.0150	0.0970	-0.0560	0.1515	0.3810	0.1510
120.	1.927	1047.65	1054.26	1051.35	1073.02	0.5500	0.2360	0.0185	0.1525	0.0210	0.2360	0.4580	0.2125
160.	2.533	1366.93	1397.17	1385.92	1416.30	1.1100	0.2890	0.0355	0.1790	0.0680	0.2890	0.5090	0.2555

DIAL GAUGES READ TO NEAREST .001 INCH

7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0055	0.0070	0.0115	0.0140	0.0155	0.0125	0.0075	0.0080	0.0065	0.0120	0.0140	0.0145	0.0135	0.0105	0.0050
0.0095	0.0145	0.0225	0.0280	0.0300	0.0270	0.0185	0.0150	0.0145	0.0240	0.0285	0.0305	0.0285	0.0225	0.0120
0.0150	0.0225	0.0355	0.0440	0.0460	0.0430	0.0300	0.0240	0.0225	0.0370	0.0440	0.0470	0.0440	0.0350	0.0190
0.0205	0.0310	0.0490	0.0600	0.0630	0.0590	0.0430	0.0325	0.0325	0.0505	0.0600	0.0640	0.0595	0.0485	0.0280
0.0170	0.0245	0.0380	0.0465	0.0505	0.0460	0.0315	0.0260	0.0255	0.0390	0.0465	0.0495	0.0465	0.0375	0.0210
0.0125	0.0175	0.0260	0.0320	0.0345	0.0310	0.0185	0.0185	0.0170	0.0275	0.0320	0.0335	0.0315	0.0255	0.0130
0.0075	0.0090	0.0130	0.0160	0.0175	0.0150	0.0045	0.0100	0.0080	0.0145	0.0170	0.0170	0.0160	0.0125	0.0040
0.0020	0.0015	0.0015	0.0020	0.0025	0.0	-0.0070	0.0015	0.0005	0.0025	0.0030	0.0015	0.0020	0.0010	-0.0035
0.0030	0.0005	-0.0005	0.0000	0.0005	-0.0020	-0.0100	0.0010	-0.0005	0.0005	0.0	-0.0010	-0.0005	-0.0010	-0.0055
0.0085	0.0095	0.0135	0.0175	0.0175	0.0155	0.0045	0.0090	0.0080	0.0150	0.0175	0.0175	0.0160	0.0125	0.0030
0.0125	0.0160	0.0230	0.0285	0.0295	0.0265	0.0135	0.0150	0.0145	0.0240	0.0285	0.0295	0.0270	0.0215	0.0090
0.0170	0.0225	0.0345	0.0430	0.0445	0.0415	0.0255	0.0230	0.0225	0.0360	0.0425	0.0445	0.0420	0.0335	0.0170
0.0220	0.0305	0.0470	0.0595	0.0615	0.0565	0.0380	0.0310	0.0310	0.0490	0.0580	0.0610	0.0575	0.0465	0.0250
0.0320	0.0465	0.0740	0.0910	0.0970	0.0900	0.0655	0.0495	0.0490	0.0770	0.0915	0.0975	0.0915	0.0740	0.0430
0.0425	0.0650	0.1015	0.1245	0.1335	0.1245	0.0930	0.0675	0.0685	0.1065	0.1260	0.1350	0.1265	0.1030	0.0615
0.0535	0.0835	0.1315	0.1610	0.1720	0.1610	0.1225	0.0880	0.0870	0.1375	0.1640	0.1750	0.1645	0.1350	0.0825
0.0645	0.1035	0.1625	0.1390	0.2130	0.1995	0.1545	0.1085	0.1110	0.1665	0.2040	0.2180	0.2055	0.1685	0.1045
0.0850	0.1410	0.2255	0.2765	0.2965	0.2785	0.2200	0.1520	0.1580	0.2425	0.2895	0.3095	0.2920	0.2395	0.1505
0.1055	0.1895	0.2985	0.3645	0.3905	0.3685	0.2950	0.2005	0.2065	0.3260	0.3890	0.4170	0.3940	0.3265	0.2065
0.1265	0.2405	0.3610	0.4640	0.4970	0.4700	0.3790	0.2560	0.2710	0.4245	0.5055	0.5425	0.5140	0.4265	0.2730
0.0	0.2995	0.4760	0.5785	0.6205	0.5875	0.4785	0.3210	0.3455	0.5410	0.6445	0.6925	0.6580	0.5485	0.3540
0.0	0.1585	0.2410	0.2875	0.3055	0.2905	0.2355	0.1680	0.1685	0.2590	0.3045	0.3245	0.3130	0.2665	0.1740
0.0	0.0345	0.0470	0.0545	0.0565	0.0525	0.0365	0.0360	0.0335	0.0520	0.0585	0.0595	0.0600	0.0525	0.0320
-0.0090	0.0235	0.0270	0.0310	0.0315	0.1290	0.0105	0.0230	0.0200	0.0335	0.0355	0.0360	0.0365	0.0330	0.0145
0.0355	0.0890	0.1315	0.1580	0.1675	0.1570	0.1180	0.0945	0.0905	0.1395	0.1620	0.1720	0.2665	0.1400	0.0870
0.0800	0.1680	0.2560	0.3100	0.1300	0.3120	0.2470	0.1790	0.1785	0.2750	0.3225	0.3450	0.3315	0.2815	0.1805
0.1150	0.2525	0.3315	0.4745	0.5065	0.4805	0.3860	0.2700	0.2700	0.4350	0.5135	0.5510	0.5275	0.4455	0.2880
0.1415	0.4640	0.6925	0.8170	0.8660	0.8135	0.6525	0.4320	0.7020	0.9735	1.0855	1.1170	1.0295	0.8465	0.5390

TABLE D1 CONTINUED

DIAL GAUGES READ TO NEAREST .001 INCH EXCEPT FOR NOS 32&33 TO .0001 INCH

22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0080	0.0155	0.0130	0.0150	0.0145	0.0115	0.0070	0.0080	0.0120	0.0085	0.00235	0.00265	0.0055	0.0050	0.0025
0.0160	0.0240	0.0285	0.0315	0.0290	0.0245	0.0155	0.0170	0.0250	0.0185	0.00430	0.00410	0.0070	0.0060	0.0035
0.0240	0.0370	0.0440	0.0485	0.0450	0.0370	0.0240	0.0270	0.0385	0.0290	0.00605	0.00620	0.0080	0.0070	0.0050
0.0290	0.0515	0.0575	0.0655	0.0615	0.0510	0.0330	0.0375	0.0530	0.0405	0.00815	0.00840	0.0095	0.0085	0.0065
0.0260	0.0400	0.0465	0.0505	0.0480	0.0395	0.0270	0.0300	0.0425	0.0320	0.00635	0.00670	0.0075	0.0070	0.0060
0.0185	0.1775	0.0315	0.0345	0.0330	0.0280	0.0190	0.0210	0.0300	0.0220	0.00465	0.00490	0.0055	0.0045	0.0040
0.0090	0.3150	0.0160	0.0180	0.0170	0.0150	0.0110	0.0120	0.0170	0.0130	0.00260	0.00280	0.0035	0.0020	0.0015
0.0030	0.3025	0.0025	0.0030	0.0035	0.0030	0.0030	0.0035	0.0050	0.0040	0.00080	0.00035	0.0015	0.0	0.0
0.0020	0.3010	0.0010	0.0010	0.0015	0.0020	0.0015	0.0045	0.0060	0.0030	0.00040	-0.00010	-0.0005	-0.0025	-0.0020
0.0110	0.3160	0.0175	0.0205	0.0190	0.0160	0.0100	0.0160	0.0220	0.0165	0.00260	0.00255	0.0005	-0.0015	-0.0020
0.0170	0.3250	0.0285	0.0325	0.0300	0.0255	0.0160	0.0230	0.0320	0.0235	0.00415	0.00405	0.0015	0.0	-0.0005
0.0250	0.3370	0.0435	0.0480	0.0450	0.0370	0.0240	0.0310	0.0440	0.0335	0.00565	0.00605	0.0030	0.0015	0.0005
0.0330	0.3505	0.0575	0.0645	0.0605	0.0495	0.0320	0.0405	0.0570	0.0425	0.00750	0.00800	0.0050	0.0040	0.0025
0.0510	0.3780	0.0925	0.0795	0.0935	0.0770	0.0500	0.0590	0.0830	0.0625	0.01125	0.01225	0.0090	0.0085	0.0070
0.0695	0.4065	0.1270	0.1360	0.1275	0.1050	0.0685	0.0780	0.1100	0.0815	0.01550	0.01645	0.0130	0.0135	0.0120
0.0890	0.4365	0.1630	0.1740	0.1645	0.1350	0.0880	0.0965	0.1360	0.1010	0.01975	0.02075	0.0185	0.0210	0.0180
0.1100	0.1675	0.2010	0.2145	0.2025	0.1660	0.1080	0.1140	0.1610	0.1195	0.02415	0.02510	0.0375	0.0300	0.0260
0.1515	0.2275	0.2795	0.2975	0.2810	0.2305	0.1505	0.1475	0.2095	0.1560	0.03210	0.03380	0.0440	0.0510	0.0440
0.1985	0.3055	0.3675	0.3905	0.3690	0.3045	0.1990	0.1805	0.2565	0.1920	0.04045	0.04280	0.0635	0.0750	0.0650
0.2520	0.3880	0.4675	0.4970	0.4720	0.3895	0.2555	0.2135	0.3040	0.2285	0.04875	0.05190	0.0895	0.1050	0.0915
0.0	0.4830	0.5835	0.6205	0.5920	0.4935	0.3280	0.			0.03880	0.06250	0.1280	0.1400	0.1215
0.0	0.2390	0.2855	0.3035	0.2940	0.2525	0.1760				0.03170	0.03520	0.0480	0.0450	0.0425
0.0	0.0440	0.0485	0.0535	0.0530	0.0475	0.0360				0.00860	0.00700	0.0210	0.0120	0.0115
0.0200	0.0230	0.0225	0.0290	0.0285	0.0265	0.0230	0.0	0.0	0.0	0.00770	0.00625	-0.7190	0.0180	0.0150
0.0900	0.1315	0.1520	0.1680	0.1605	0.1380	0.0980	0.0810	0.1140	0.0885	0.02240	0.02390	-0.7040	0.0345	0.0310
0.1720	0.2570	0.3045	0.3295	0.3160	0.2695	0.1885	0.1570	0.2195	0.1715	0.03570	0.04075	-0.6740	0.0665	0.0595
0.2605	0.3965	0.4745	0.5095	0.4890	0.4145	0.2835	0.2215	0.3085	0.2410	0.04955	0.05665	-0.6320	0.1155	0.1020
0.7140	0.9980	1.0855	1.0585	0.9610	0.7885	0.5170	0.6195	0.6770	0.4650	0.13225	0.08115	-0.5160	0.2550	0.2060

DIAL GAUGES CONTD.

37	18	4
0.0	0.0	0.0
0.0010	0.0145	0.0105
-0.0005	0.0305	0.0230
-0.0020	0.0475	0.0365
-0.0035	0.0640	0.0490
-0.0020	0.0495	0.0400
0.0	0.0335	0.0280
0.0020	0.0155	0.0150
0.0020	0.0015	0.0040
0.0045	-0.0010	0.0050
0.0040	0.0175	0.0205
0.0030	0.0290	0.0295
0.0010	0.0445	0.0410
0.0	0.0610	0.0530
-0.0040	0.0975	0.0785
-0.0085	0.1350	0.1035
-0.0140	0.1755	0.1295
-0.0175	0.2185	0.1560
-0.0295	0.3100	0.2035
-0.0480	0.4160	0.2520
-0.0730	0.5435	0.3020
-0.1100	0.7065	0.0
-0.0400	0.0	0.0
-0.0030	0.0585	0.0
-0.0105	0.0360	-0.0615
-0.0140	0.1725	0.0450
-0.0315	0.3455	0.1520
-0.0655	0.5525	0.2365
0.0	1.1175	0.2900

TABLE D1 CONTINUED
- SHELL 2, NAILED

APPROX. PRESS. LB/SQFT	WATER MANOMETER FT HEAD	LOAD CELL LOADINGS LBS SW	SE	NE	NW	DIAL GAUGES READ TO NEAREST .001 INCH 18	4	1	2	3	4	5	6
0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.	0.080	37.81	37.73	37.67	36.54	0.0280	0.0195	0.0070	0.0130	0.0180	0.0195	0.0185	0.0145
10.	0.155	92.30	82.12	84.20	83.05	0.0715	0.0485	0.0195	0.0330	0.0445	0.0485	0.0465	0.0365
15.	0.241	124.56	124.29	127.40	128.45	0.1505	0.0945	0.0385	0.0670	0.0880	0.0945	0.0900	0.0705
20.	0.322	164.60	166.46	166.18	169.42	0.2445	0.1450	0.0590	0.1045	0.1350	0.1445	0.1365	0.1070
15.	0.240	122.34	127.62	125.19	130.67	0.2250	0.1325	0.0545	0.0965	0.1235	0.1325	0.1250	0.0980
10.	0.160	80.07	83.23	79.77	85.27	0.2010	0.1175	0.0480	0.0855	0.1095	0.1175	0.1110	0.0865
5.	0.081	37.81	44.39	40.99	44.29	0.1745	0.1010	0.0420	0.0745	0.0945	0.1015	0.0950	0.0735
0.	0.008	2.22	5.55	4.43	4.43	0.1410	0.0815	0.0340	0.0605	0.0760	0.0815	0.0760	0.0580
5.	0.080	42.26	46.61	40.99	45.40	0.1585	0.0950	0.0390	0.0695	0.0885	0.0950	0.0885	0.0685
10.	0.160	86.75	93.22	84.20	86.37	0.1795	0.1105	0.0455	0.0810	0.1030	0.1105	0.1035	0.0805
15.	0.238	126.79	135.39	129.62	133.99	0.2045	0.1270	0.0525	0.0925	0.1190	0.1270	0.1190	0.0930
20.	0.320	169.05	179.78	171.72	176.07	0.2390	0.1475	0.0610	0.1065	0.1375	0.1475	0.1385	0.1090
20.	0.320	169.05	182.00	169.50	176.07	0.2410	0.1520	0.0630	0.1100	0.1430	0.1520	0.1420	0.1120
25.	0.400	211.31	224.17	210.49	220.36	0.3440	0.2075	0.0860	0.1500	0.1950	0.2075	0.1945	0.1510
30.	0.484	250.23	268.56	252.59	263.55	0.4735	0.2715	0.1125	0.1975	0.2555	0.2720	0.2535	0.1970
35.	0.557	291.38	308.51	291.36	302.31	0.6025	0.3340	0.1375	0.2425	0.3135	0.3335	0.3110	0.2400
40.	0.639	333.64	356.23	332.35	346.60	0.7555	0.4025	0.1660	0.2930	0.3780	0.4055	0.3745	0.2890
45.	0.720	378.13	400.62	377.78	389.79	0.9355	0.4795	0.1975	0.3485	0.4500	0.4795	0.4455	0.3435
50.	0.801	420.39	445.01	419.87	434.08	1.1250	0.5560	0.2285	0.4035	0.5230	0.5560	0.5170	0.3975
55.	0.883	462.65	490.51	463.08	476.16	1.3305	0.6345	0.2605	0.4605	0.5970	0.6345	0.5890	0.4515
65.	1.043	547.18	581.51	548.39	561.43	1.8745	0.8145	0.3330	0.5420	0.7650	0.8145	0.7535	0.5740
75.	1.200	633.93	666.96	624.83	644.48	2.8420	1.0125	0.4180	0.6345	0.9570	1.0120	0.9365	0.6945

DIAL GAUGES READ TO NEAREST .001 INCH

7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0090	0.0150	0.0215	0.0215	0.0255	0.0250	0.0215	0.0145	0.0200	0.0255	0.0275	0.0275	0.0270	0.0225	0.0160
0.0210	0.0370	0.0545	0.0630	0.0655	0.0645	0.0565	0.0360	0.0470	0.0635	0.0700	0.0720	0.0705	0.0625	0.0415
0.0400	0.0740	0.1125	0.1300	0.1340	0.1325	0.1200	0.0720	0.0920	0.1325	0.1470	0.1505	0.1495	0.1345	0.0860
0.0605	0.1150	0.1830	0.2105	0.2165	0.2145	0.1715	0.1120	0.1435	0.2155	0.2410	0.2445	0.2430	0.2190	0.1350
0.0545	0.1070	0.1720	0.1935	0.1990	0.1975	0.1770	0.1045	0.1340	0.1995	0.2195	0.2245	0.2245	0.2040	0.1245
0.0480	0.0960	0.1535	0.1725	0.1765	0.1770	0.1600	0.0935	0.1190	0.1800	0.2000	0.2015	0.2030	0.1860	0.1140
0.0410	0.0835	0.1345	0.1485	0.1525	0.1540	0.1405	0.0805	0.1015	0.1550	0.1720	0.1745	0.1785	0.1640	0.1000
0.0315	0.0665	0.1085	0.1195	0.1225	0.1255	0.1155	0.0640	0.0765	0.1235	0.1390	0.1410	0.1465	0.1375	0.0805
0.0380	0.0745	0.1220	0.1365	0.1400	0.1420	0.1290	0.0725	0.0865	0.1385	0.1560	0.1590	0.1635	0.1510	0.0900
0.0450	0.0845	0.1370	0.1560	0.1605	0.1610	0.1450	0.0820	0.0980	0.1515	0.1765	0.1800	0.1830	0.1670	0.1000
0.0520	0.0970	0.1560	0.1780	0.1940	0.1835	0.1630	0.0945	0.1110	0.1770	0.2005	0.2045	0.2055	0.1670	0.1130
0.0610	0.1140	0.1820	0.2090	0.2150	0.2125	0.1890	0.1105	0.1400	0.2110	0.2355	0.2390	0.2385	0.2150	0.1320
0.0620	0.1155	0.1840	0.2110	0.2170	0.2145	0.1900	0.1120	0.1415	0.2130	0.2375	0.2410	0.2405	0.2160	0.1330
0.0840	0.1595	0.2595	0.3005	0.3075	0.3035	0.2645	0.1525	0.1915	0.3005	0.3400	0.3445	0.3425	0.3045	0.1810
0.1085	0.2110	0.3530	0.4115	0.4200	0.4115	0.3545	0.2005	0.2530	0.4095	0.4680	0.4725	0.4685	0.4105	0.2380
0.1320	0.2630	0.4440	0.5220	0.5310	0.5185	0.4420	0.2465	0.3130	0.5170	0.5560	0.6020	0.5930	0.5140	0.2930
0.1580	0.3200	0.5495	0.6520	0.6640	0.6445	0.5425	0.2990	0.3800	0.6410	0.7465	0.7560	0.7420	0.6355	0.3555
0.1875	0.3880	0.6735	0.8045	0.8130	0.7915	0.6605	0.3610	0.4605	0.7870	0.9245	0.9365	0.9155	0.7760	0.4305
0.2165	0.4545	0.8005	0.9620	0.9815	0.9435	0.7805	0.4230	0.5390	0.9385	1.1105	1.1255	1.0990	0.9195	0.5040
0.2455	0.5285	0.9335	1.1360	1.1575	1.1090	0.9100	0.4895	0.6285	1.1060	1.2705	1.3330	1.3000	1.0790	0.5850
0.3100	0.7050	1.2870	1.4325	1.6140	1.5330	1.2345	0.6505	0.8440	1.5305	1.8075	1.8735	1.8240	1.4815	0.7800
0.3850	0.9760	1.8505	2.2170	2.3940	2.2240	1.7325	0.8885	1.1885	2.2580	2.6595	2.8165	2.7505	2.1400	1.0825

TABLE D1 CONTINUED

DIAL GAUGES READ TO NEAREST .001 INCH EXCEPT FOR NOS 32&33 TO .0001 INCH

22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.C	0.0	0.0	0.0
0.0180	0.0255	0.0270	0.0280	0.0260	0.0225	0.0150	0.0155	0.0210	0.0150	0.C0190	0.C0200	0.0040	0.0065	0.0035
0.0415	0.0615	0.0680	0.0695	0.0670	0.0575	0.0370	0.0385	0.0515	0.0370	0.00420	0.C0390	0.0095	0.0105	0.0095
0.0775	0.1230	0.1390	0.1415	0.1375	0.1185	0.0735	0.0715	0.0980	0.0700	0.00745	0.C0595	0.0195	0.0190	0.0205
0.1185	0.1925	0.2225	0.2250	0.2190	0.1835	0.1145	0.1065	0.1470	0.1050	0.00935	0.C0810	C.0335	0.0300	0.0335
0.1090	0.1775	0.2045	0.2055	0.2015	0.1735	0.1050	0.0985	0.1355	0.0965	0.00800	0.C0665	0.0295	0.0260	0.0315
0.0960	0.1600	0.1835	0.1840	0.1810	0.1570	0.0945	0.0880	0.1215	0.0860	0.00645	0.C0480	C.0255	0.0240	0.0285
0.0785	0.1360	0.1575	0.1570	0.1560	0.1370	0.0810	0.0735	0.1025	0.0725	0.00415	0.C0305	0.0215	0.0210	0.0255
0.0560	0.1045	0.1235	0.1245	0.1255	0.1105	0.0630	0.0540	0.0765	0.0540	C.00240	0.CC100	0.0170	0.0180	0.0240
0.0655	0.1180	0.1400	0.1420	0.1420	0.1240	0.0710	0.0625	0.0885	0.0630	0.00510	0.C0280	0.0185	0.0190	0.0245
0.0760	0.1340	0.1600	0.1620	C.1615	0.1390	0.0810	0.0725	0.1020	0.0730	0.0C740	0.C0465	0.0210	0.0210	0.0265
0.0920	0.1560	0.1830	0.1860	0.1845	0.1575	0.0940	0.0855	0.1190	0.0860	0.0096C	0.C0630	C.0245	0.0230	0.0285
0.1150	0.1870	0.2160	0.2200	0.2145	0.1840	0.1120	0.1045	0.1440	0.1035	0.01180	0.C0805	0.0285	0.0270	0.0325
0.1170	0.1900	0.2190	0.2225	0.2165	0.1855	0.1125	0.1085	0.1490	0.1070	0.01265	C.C0805	0.0270	0.0250	0.0315
0.1570	0.2615	0.3060	0.3120	0.3030	0.2565	0.1530	0.1425	0.1980	0.1415	0.0147C	0.C1005	0.0415	0.0390	0.0455
0.2070	0.3490	0.4140	0.4210	0.4090	0.3420	0.2010	0.1825	0.2545	0.1815	0.01765	0.C1235	0.0615	0.0580	0.0635
0.2550	0.4355	0.5215	0.5310	0.5140	0.4255	0.2480	0.2215	0.3090	0.2210	0.02025	0.C1455	C.0805	0.0775	0.0820
0.3095	0.5340	0.6455	0.6590	0.6365	0.5220	0.3010	0.2630	0.3685	0.2625	0.02315	C.C1670	C.1030	0.1030	0.1035
0.3725	0.6485	0.7905	0.8095	0.7790	0.6345	0.3620	0.3105	0.4345	0.3100	0.02635	C.C1925	0.1285	0.1320	0.1285
0.4345	0.7660	0.9405	0.9670	0.9275	0.7480	0.4225	0.3540	0.4975	0.3545	0.029C0	0.02180	0.156C	0.1640	0.1555
0.5055	0.8950	1.1050	1.1400	1.0895	0.8720	0.4895	0.4010	0.5655	0.4015	0.03265	C.C2465	0.1875	0.2010	0.1850
0.6705	1.2130	1.5230	1.5845	1.5040	1.1815	0.6490	0.5025	0.7165	0.5070	0.03940	0.C3060	C.3685	0.3125	0.2615
0.9205	1.7255	2.2295	2.3810	2.2095	1.6600	0.7800	0.6045	0.7720	0.6225	0.04715	C.C3680	0.5455	0.4765	0.3945

DIAL GAUGES CONTD.

37	18	4
0.0	0.0	0.0
-0.0025	0.0275	0.0190
-0.0090	0.0720	0.0490
-0.0235	0.1500	0.0945
-0.0435	0.2450	0.145C
-0.0415	0.2270	0.1350
-0.0375	0.2015	0.1175
-0.0345	0.1720	0.1015
-0.0300	0.1410	0.0810
-0.0325	0.1590	C.0950
-0.0355	0.1800	0.1105
-0.0385	0.2045	0.1270
-0.0435	C.2395	0.1480
-0.0410	0.2405	0.1520
-0.0625	0.3440	0.208C
-0.0905	0.4725	0.2720
-0.1185	0.6020	0.3340
-0.1515	0.7570	0.4035
-0.1900	0.9355	0.4800
-0.2310	1.1255	0.5565
-0.2765	1.3340	0.6350
-0.3985	1.8715	0.819C
-0.6050	2.8340	0.3950